THE TANJORE MAHARAJA SERFOGI'S SARASWATI MAHAL.
2775
1
2776

NATURAL HISTORY,

GENERAL AND PARTICULAI

BY THE

COUNT DE BUFFON.

VOL. III.

HISTORY OF MAN.

Sevajee Rajah 1821

NATURAL HISTORY,

GENERAL AND PARTICULAR,

BY THE

COUNT DE BUFFON,

ILLUSTRATED WITH ABOVE SIX HUNDRED COPPER PLATES.

2

2776

THE

HISTORY OF MAN AND QUADRUPEDS

TRANSLATED, WITH NOTES AND OBSERVATIONS,

BY WILLIAM SMELLIE,

MEMBER OF THE ANTIQUARIAN AND ROYAL SOCIETIES OF EDINBURGH.

A NEW EDITION,

CAREFULLY CORRECTED AND CONSIDERABLY ENLARGED, BY MANY ADDITIONAL ARTICLES, NOTES, AND PLATES,

AND

SOME ACCOUNT OF THE LIFE OF M. DE BUFFON.

BY WILLIAM WOOD, F. L. S.

IN TWENTY VOLUMES.

VOL. III.

LONDON:

PRINTED FOR T. CADELL AND W. DAVIES, STRAND; F. C. AND J. RIVINGTON; WILKIE AND ROBINSON; F. WINGRAVE; J. WALKER; SCATCHERD AND LETTERMAN; R. LEA; J. CUTHELL; CLARKE AND SONS; LACKINGTON, ALLEN, AND CO.; C. LAW; WHITE AND COCHRANE; LONGMAN, HURST, REES, ORME, AND BROWN; JOHN RICHARDSON; J. M. RICHARDSON; J. BOOKER; B. CROSBY AND CO.; E. JEFFERY; BLACK, PARRY, AND KINGSBURY; J. HARDING; J. MAWMAN; J. BOOTH; J. ASPERNE; J. HARRIS; P. AND W. WYNNE; R. SCHOLEY; R. BALDWIN; J. BLACKLOCK; T. HAMILTON; J. FAULDER; SHERWOOD, NEELEY, AND JONES; J. JOHNSON AND CO.; T. UNDERWOOD; R. SAUNDERS; AND WILSON AND SON, AT YORK.

1812.

Printed by C. Wood,
Poppin's Court, Fleet Street, London.

CONTENTS.

	PAGE.
General History of Animals	1
CHAP. IX. *Varieties in the Generation of Animals*	ibid.
X. *On the Formation of the Fœtus*	16
XI. *Of the Expansion, Growth, and Delivery of the Fœtus, &c.*	46
Recapitulation	87
The Natural History of Man	95
SECT. I. *Of the Nature of Man*	ibid.
II. *Of Infancy*	110
III. *Of Puberty*	139
IV. *Of Manhood*	172
V. *Of Old Age and Death*	204
VI. *Of the Sense of Seeing*	250
VII. *Of the Sense of Hearing*	273
VIII. *Of the Senses in General*	286
IX. *Of the Varieties of the Human Species*	302
Of Nature	447
First View	ibid.
Second View	461
A Dissertation on the Nature of Animals	481
Homo Duplex	533

ERRATA.

Page 220, line 7, *for* "affinity" *read* infinity.
276, line 12 from bottom, *for* "one" *read* tone.

DIRECTIONS TO THE BINDER.

		To face Page
Plate XVI.	The Passions	184

THE TANJORE MAHARAJA SERFOJI'S SARASWATI MAHAL.

GENERAL HISTORY OF ANIMALS.

CHAP. IX.

Varieties in the Generation of Animals.

THE nutrition and the reproduction of animals and of vegetables, are effected (as we have observed in the preceding chapter) by the same matter. It is a substance universally prolific, and composed of organic particles, the union of which gives rise to all organized bodies. Nature always works on the same stock, and this stock is inexhaustible. But the means she employs to give it value are various; and these general varieties and affinities merit the attention of philosophers, because from them we are enabled to account for particular exceptions to the common plan of her operations.

In general, large animals are less prolific than small ones. The whale, the elephant, the rhinoceros, the horse, man, &c., produce but one, and very rarely two at a birth. But small ani-

mals, as rats, herrings, and insects, produce a great number. Does this difference proceed from the greater quantity of nourishment necessary to support the large animals than the small, and from the former having a less proportional quantity of superfluous nutritive particles, capable of being converted into semen, than the former? It is certain that the small animals eat more, in proportion to their bulk, than the large. But it is likewise probable, that the prodigious increase of the smaller animals, as bees, flies, and other insects, may be owing to the extreme fineness and delicacy of their organs and members, by which they are enabled to select the most substantial and most organic parts of the animals and vegetables, from which they extract their nourishment. A bee, which lives upon the purest and most refined parts of flowers, receives from its food a greater proportional quantity of organic particles than a horse, who feeds upon hay, straw, and the grosser parts of vegetables. The horse, accordingly, produces but one at a time, while the bee produces many thousands. The oviparous animals are, in general, smaller than the viviparous, and they are likewise much more prolific. The long time that the fœtus remains in the uterus of viviparous animals, is another obstacle to multiplication: during gestation, and the suckling of the young, no new generation can take place. But the oviparous animals, which produce, at the same time, both uterus and fœtus, and throw them out of the body, are almost perpetually in

a condition to reproduce; and it is well known, that, if a hen be prevented from sitting, and be fully fed, the number of her eggs may be greatly increased. If hens lay not while they brood, it is because they cease to eat; and for this purpose they leave not their nests but once a day, and even then for a very short time, lest their eggs should be injured by the cold. During this operation, they take not above one tenth part of their ordinary nourishment.

Animals which produce but one at a birth, acquire nearly their full growth before they are fit for generating. But those which produce many, generate before they are half grown. Man, the horse, the ass, the sheep, are incapable of generation till after they have nearly acquired their full growth. It is the same with pigeons, and other birds which lay only a small number of eggs: but those which are more prolific, as cocks and hens, fishes, &c., begin to generate much sooner. A cock is capable of this operation at the age of three months, when he is not above one third of his full size. A fish, which, in twenty years will weigh thirty pounds, generates the first or second year, when it weighs not, perhaps, more than half a pound. But experiments are still wanting to ascertain the growth and duration of fishes: their age may be discovered by examining with a microscope the annual rings or strata of which their scales are composed. But we are ignorant how far this may extend. I have seen in the count de Maurepas' ponds, carps which were well attested

to be at least 150 years old, and they appeared to be equally active and lively as common carps. I will not say, with Leeuwenhoek, that fishes are immortal, or, at least, that they cannot die of old age. Every thing, in time, must perish. Whatever has an origin, a birth, or commencement, must arrive at a termination or death. But fishes, by living in a uniform element, and being sheltered from the injurious vicissitudes of the air, must continue longer in the same state than other animals, especially if these vicissitudes, as Bacon remarks, be the chief causes of the destruction of animated beings. But the principal cause of the longevity of fishes is, that their bones are softer than those of other animals, and do not perceptibly harden with age. The bones of fishes lengthen, and turn thick without acquiring more solidity. But the density of the bones of other animals continually increases; and, when their interstices are completely filled and obstructed, the circulation of their fluids ceases, and death ensues. But, in the bones of fishes, this augmentation of solidity, which is the natural cause of death, proceeds in such an imperceptible manner, that they must live very long before they can feel any of the effects of old age.

All quadrupeds covered with hair are viviparous, and those covered with scales are oviparous. The close texture of the shells or scales of oviparous animals prevents them from losing so much matter by transpiration, as makes its way through the porous skins of the viviparous. May not this retention of superfluous nourish-

ment, which cannot escape by transpiration, be one reason of the extraordinary fertility of these animals, and of their being able to subsist a long time without food? All birds and flying insects are oviparous, except some species of flies, which produce their young alive*. These have no wings immediately after their birth; but they gradually shoot out as the animal advances in growth; and they are not in a condition to be used till it acquires full maturity. All shell-fishes are oviparous; and likewise those reptiles that have no feet, as snakes and serpents; they change their skins, which are composed of small scales. The viper is but a slight objection to this general rule; for it is not properly viviparous. It first produces eggs, from which the young are hatched: this operation is indeed carried on and completed in the body of the mother; and, instead of laying the eggs, like other oviparous animals, the viper hatches them within the body. The salamander, in which, as Maupertuis remarks †, both eggs and young are found, at the same time, is a similar exception in oviparous quadrupeds.

Most animals are multiplied and perpetuated by copulation. But many animals, as the greatest number of birds, propagate rather by a kind of compression, than a proper copulation. Some birds, indeed, as the ostrich, the male duck, &c., have considerable members, and propagate by a real intromission. Male fishes approach the fe-

* See Leeuwenhoek, tom, iv. p. 91.

† Mem. de l'Acad. ann. 1727, p. 32.

males in the season of spawning. They seem to rub their bellies against each other; for the male often turns on his back to meet the belly of the female. But no actual copulation takes place. The part necessary for this operation does not exist; and the males only approach the females for the purpose of shedding the liquor of their milts upon the eggs, which at that season drop from the females. The male seems to be more attached to the eggs than to the female; for, when she ceases to throw out the eggs, the male instantly abandons her, and follows, with ardor, the eggs, which are carried down by the stream, or dispersed by the wind. He passes and repasses a thousand times over every place where he finds eggs. It is not, surely, for the love of the mother that he makes all these movements: he cannot even be supposed to know her; for he has been often seen shedding his semen promiscuously on all the eggs that came in his way, without having ever met with the female to which they belonged.

Thus some animals are distinguished by sexes, and endowed with members proper for copulation. There are others which likewise have sexes, but want the necessary members. Others, as snails, have both members and both sexes in each individual. Others, as the vine-fretters, have no sexes, are equally fathers and mothers, and produce of themselves without copulation. Though they seem to copulate at pleasure, we are unable to discover the use of the junction, or whether it be really a sexual embrace; unless we should suppose Nature to have endowed this small insect

with generative faculties superior to those of any other species of animals, and to have bestowed on every individual not only the power of reproduction, but likewise the power of multiplying by sexual communications.

But, whatever varieties take place in the generation of different species of animals, Nature prepares the body for it by a new production, which, whether it be external or internal, always precedes generation: immediately before the season of impregnation, the ovaria of oviparous animals, and the testicles of the females of the viviparous, undergo a considerable change. The oviparous animals produce eggs, which gradually increase in size, till they quit the ovarium and fall into the canal of the uterus, where they receive their white, their membranes, and their shell. This production marks the fecundity of the female, and without which generation could not be effected. In viviparous females, in the same manner, one or more glandulous bodies appear upon the testicles, which gradually grow under the membranes that cover them. These glandulous bodies increase, and pierce, or rather elevate the membrane of the testicle; and, when they arrive at maturity, a fissure, or several little holes, appear at their extremities, through which the seminal fluid escapes, and falls into the uterus. These glandulous bodies are new productions, which always precede generation, and without which it could not be effected.

Males undergo a similar change before they are fit for the purposes of generating. In the oviparous animals, the seminal reservoirs are

filled, and sometimes the reservoirs themselves are annually renewed. The milts of some fishes, and particularly of the calmar, are renewed every year. The testicles of birds immediately before the season of their amours, swell to an enormous degree. The testicles of the males of viviparous animals, especially of those which have seasons, likewise swell considerably: and, in general, the genitals of every species suffer an erection, which, though it be external and casual, may be regarded as a new production that necessarily precedes the faculty of generating.

Thus in all animals, whether male or female, generation is always preceded by new productions; and, when there is properly no new production, some of the parts swell and extend to a remarkable degree. In some animals, not only a new production appears, but their whole bodies are renewed, before generation can be effected; as happens in the surprising metamorphosis of insects, which seems to be intended for no other purpose than to enable these animals to propagate their species; for their bodies are full grown before they are transformed. The insect, immediately before its transformation, ceases to take nourishment; and it has no organs proper for generation, no means of converting the nutritive particles, with which it abounds more than any other species of animals, into eggs, or a seminal fluid. Hence the whole of this great surplus of nutritive particles at first unites and moulds itself into a form nearly resembling that of the original animal. The ca-

terpillar becomes a butterfly, because, having no organs of generation, no reservoirs for containing the superfluous nutritive particles, and, consequently, being incapable of producing minute organic bodies similar to the animal itself, the organic nutritive particles, which are always active, assume, by their union, the form of a butterfly, partly resembling that of a caterpillar, both internally and externally, except that the parts of generation are unfolded, and rendered capable of receiving and transmitting the nutritive organic particles which form the eggs and individuals peculiar to the species. The individuals produced by the butterfly ought not to be butterflies, but caterpillars; because it was the caterpillar that received the nourishment, and because the organic particles of this nourishment must therefore be assimilated into the form of a caterpillar, and not of a butterfly, which is only an occasional production of the superfluous nourishment that precedes the real production of animals of this species, and a method employed by Nature to accomplish the important purposes of generation, similar to the production of glandulous bodies, and of milts, in other animals.

When the superabundant quantity of organic nutritive particles is not great, as in man, and most large animals, generation does not take place till the growth of the body is nearly completed; and even their prolific powers are limited to a small number of young: but, when these particles are more abundant, as in birds and oviparous fishes, generation is effected before the

animal be fully grown, and the production of individuals is very numerous. When the quantity of organic nutritive particles is still greater, as in insects, it first produces a large organized body, retaining the internal and essential constitution of the animal, but differing in several parts, as the butterfly differs from the caterpillar; and then it quickly generates an amazing number of young, similar to the animal that first prepared the organic nourishment from which they derived their origin. Lastly, when the quantity of superfluous nourishment is very great, and when the animal, at the same time, possesses the organs necessary to generation, as in the vine-fretters, it first confers on each individual the power of generating, and then a transformation like that which other insects undergo: the vine-fretter becomes a fly; but it can produce nothing, because it is only the residue of the organic particles that had not been employed in the production of the young.

Almost all animals, man excepted, have certain annual seasons appropriated to the purposes of generation. To birds, spring is the season of love: carps, and several other fishes, spawn in June and August. Pikes, and some other fishes, spawn in the spring. Cats have three seasons annually, in the months of January, May, and September. The roe-deer rut in December, wolves and foxes in January, horses in summer, stags in September and October; and almost all insects generate during the autumn only. Some animals, as the insects, are totally exhausted by

generation, and die soon after. Others, though they die not, become feeble, are much emaciated, and require a considerable time to repair the great waste of their organic substance. Others are less affected, and are capable of frequently renewing their amours; lastly, man is very little affected, or rather, he quickly repairs the loss, and therefore is, at all times, in a condition for propagating. All these varieties depend solely on the particular construction of the animal organs. The limits fixed by Nature upon the modes of existing are equally conspicuous in the manner of taking and digesting the food, in the means employed for retaining or throwing it out of the body, and in the instruments by which the organic particles necessary to reproduction are extracted. And, upon the whole, it is apparent that every thing exists which can exist.

The times of the gestation of females are equally various: some, as mares, carry their young from eleven to twelve months; others, as women, cows, and hinds, carry their young nine months; others, as foxes and wolves, carry five months; bitches carry nine weeks, cats six weeks, and rabbits thirty-one days. Most birds are hatched in twenty-one days; though some of them, as the thistle finches, hatch in thirteen or fourteen days. Here the variety is equally great as in every other part of the economy of animals: the largest animals produce fewer young, and carry them longest, which confirms the doctrine, that the quantity of organic nou-

rishment is proportionally less in large than in small animals; for the fœtus derives its growth and the expansion of its parts from the superfluous nourishment of the mother: and as this growth requires longer time in large than in small animals, it is a proof that the quantity of organic particles is not so great in the former as in the latter.

Animals, therefore, are much diversified as to the time and manner of gestation, of engendering, and of producing; and this variety originates from the very causes of generation. For, though the organic matter, which is common to every thing that lives or vegetates, be the general principle of reproduction, the manner of its union, and the combinations it forms, must be infinitely varied, that the whole may become the sources of new productions. My experiments clearly demonstrate, that there are no preexisting germs, and that the generation of animals and vegetables is not univocal. There are, perhaps, as many beings, which either live or vegetate, produced by a fortuitous assemblage of organic particles, as by a constant and successive generation. It is to such productions that we ought to apply the axiom of the ancients, *Corruptio unius, generatio alterius.* The corruption and resolution of animals and vegetables produce an infinite variety of organized bodies: some of them, as those of the calmar, are only a kind of machines, which, though exceedingly simple, are very active. Others, as the spermatic animalcules, seem to imitate the move-

ments of animals. Others resemble vegetables in their manner of growth and expansion. There are others, as those of blighted wheat, which, at pleasure, can be made alternately to live or to die; and it is difficult to know to what they should be compared. There are still others, and in great numbers, which are at first a kind of vegetables, then become a species of animals, and again return alternately to their vegetable state. The more we examine this species of organized bodies, we shall probably discover greater and more singular varieties of them, in proportion as they are farther removed from our observation, and from the structure of other animals with which we are already acquainted.

For example, blighted corn, which is effected by an alteration or resolution of the organic substance of the grain, is composed of multitudes of small organized bodies resembling eels. When infused in water for ten or twelve hours, we discover them to have a distinct wreathing, and a small degree of progressive motion. They cease to move as soon as the water fails them; and their motion commences upon the addition of fresh water. This alternate death and reviviscence may be repeated for months, and even for years; so that these small machines may be made to act as long and as often as we please, without destroying or diminishing their force. They are a species of machines, which begin to act whenever they are immersed in a fluid. These filaments sometimes open like the filaments of the semen, and produce moving globules: we

may, therefore, conclude them to be of the same nature, except that they are more fixed and solid.

The eels in paste have no other origin than the union of the organic particles of the most essential parts of the grain. The first eels which appear are certainly not produced by other eels; but, though they are not propagated themselves, they fail not to engender other living eels. By cutting them with the point of a lancet, we discover smaller eels issuing in great numbers out of their bodies. The body of this animal seems to be only a sheath or sac containing a multitude of smaller animals, which perhaps are other sheaths of the same kind, in which the organic matter is assimilated into the form of eels.

A great number of experiments would still be necessary to distinguish these animals, which are so singular and so little understood, into classes and genera. Some of them may be regarded as real zoophytes, which enjoy a kind of vegetation, and which, at the same time, seem to wreath and move like animals. Others appear, at first, to be animals, and then join and form a species of vegetables. A small attention to the resolution of a single grain of corn will elucidate, at least in part, what I have said on this subject. I might add other examples; but those I have given were only produced for the purpose of exhibiting the varieties of generation. There are unquestionably several organized bodies which we consider as real animals, but which are not engendered by others of the same species. Some

of them are only a kind of machines; and some of these machines have a certain limited effect, and act for a certain time only, as the machines in the milt of the calmar; others may be made to act as long and as often as we please, as those of blighted grain. There are vegetables which produce animated bodies, as the filaments of the human semen, from which active globules issue and move by their own powers. In the corruption, the fermentation, or rather in the resolution of animal or vegetable substances, we find real animals, capable of propagating their species, though they were not themselves produced in this manner. These varieties are, perhaps, more extensive than we imagine. Though it be right to generalize our ideas, to assemble the effects of Nature under one point of view, and to class her productions; yet numberless shades, and even degrees, in the great scale of being, will always escape our observation.

CHAP. X.

On the Formation of the Fœtus.

FROM the experiments of Verheyen, who found the semen of the bull in the uterus of a cow, and from those of Ruysch, Fallopius, and Leeuwenhoek, who discovered male semen in the uteri of women and many other animals, it seems to be a point fully ascertained, that the semen of the male enters into the uterus of the female. It is probable, that, during the time of coition, the orifice of the uterus opens for the reception of the seminal fluid: but, though this should not happen, the active and prolific part of the semen may penetrate the membranes and substance of the uterus itself; for, as the seminal liquor, as formerly remarked, is almost entirely composed of organic particles, which are very active, and extremely minute, they may pass with the utmost facility through the membranes and substance of the uterus.

What proves that the active part of this fluid may pass through the pores and substance of the uterus, is the sudden change it undergoes immediately after conception. The menses are obstructed, the uterus becomes flaccid, swells, and appears to be inflated. All these changes

must be effected by an active external cause, by the penetration of part of the seminal fluid into the substance of the uterus. This penetration is not confined to the surface; it extends through all the vessels and parts of which the uterus is composed, like that penetration by which nutrition, and the expansion of the body, is produced.

We shall the more easily believe this to be the case, when we reflect, that, during the time of gestation, the uterus not only augments in size, but even in its quantity of matter, and that it possesses a species of life, or rather of vegetation, which continues till the child be delivered. If the uterus were only a sac, a reservoir for receiving the semen and retaining the fœtus, it would extend and diminish in thickness, in proportion as the fœtus grows larger. But the augmentation of the uterus is not a simple extension or dilatation of its parts. It not only extends as the fœtus enlarges, but it acquires, at the same time, an additional thickness and solidity; or, in other words, both its size and quantity of matter are greatly increased. This augmentation is a real growth or increase of substance, similar to the expansion of the body in young animals, which could not be effected but by an intimate penetration of organic particles analogous to the substance of those parts. As this expansion of the uterus never happens but after impregnation, the seminal liquor must be the cause by which it is produced; for the uterus is

considerably augmented before the fœtus has acquired bulk enough to dilate it by pressing against its internal surface.

It appears, from my own experiments, to be equally certain, that the female has a seminal fluid, which begins to be formed in the testicles, and is brought to maturity in the glandulous bodies. This fluid perpetually distils through the small apertures in the extremities of these bodies, and, like that of the male, enters the uterus by two different ways, either through the apertures at the extremities of the horns of the uterus, or by piercing through the substance of the uterus itself.

These two seminal fluids are extracts from all parts of the body; and a mixture of them is all that is necessary for the formation of a certain number of males and females. The more any animal abounds in this seminal fluid, or the more it abounds in organic particles, the number of young is the greater, as may be remarked in the smaller animals; and the number of young diminishes in proportion as the organic particles are less abundant, as is the case with the larger animals.

But, before taking any farther notice of other animals, we shall examine with attention the formation of the human fœtus. In mankind, as well as in the larger species of animals, the quantity of organic particles in the male and female semen is not great, and, accordingly, they very seldom produce above one fœtus at a time.

This fœtus is either a male or a female, according as the number of organic particles predominates in the male or in the female fluid; and the child resembles the father or the mother most, according to the proportional quantities of male or female organic particles in the mixture of the two liquors.

I conceive, therefore, that the seminal fluids, both of the male and of the female, are equally active, and equally necessary for the purposes of propagation: and this, I think, is fully proved by my experiments; for I found in both fluids the same moving bodies; I discovered that the male fluid enters the uterus, where it meets with the fluid of the female; that these two fluids are perfectly analogous; and that they are composed of parts not only similar in their form, but in their action and movements*. Now, I imagine, that, by the mixture of the two fluids, the activity of the organic particles proper to each is stopped; that the action of the one counterbalances the action of the other; that each organic particle, by ceasing to move, remains fixed in the place which corresponds to its nature; and that this place can be no other than that which it formerly occupied in the body of the animal from which it was extracted. Thus all the organic particles which were detached from the head of the animal, will arrange themselves in a similar order in the head of the fœtus. Those which

* See chap. vi.

proceeded from the back bone, will dispose themselves in an order corresponding to the structure and position of the vertebræ. In the same manner, the organic particles which had been detached from any part of the body, will naturally assume the same position, and arrange themselves in the same order that they observed before they were separated from that part. Of course, these particles will necessarily form a small organized body, entirely similar to the animal from which they originally proceeded.

It is worthy of remark, that this mixture of the organic particles of both sexes contains particles which are similar, and particles which are dissimilar. The similar particles are those which have been detached from all the parts that are common to the two sexes. The dissimilar particles are those which have been separated from the parts that distinguish the two sexes. In this mixture, therefore, there is a double portion of particles destined for the formation of the head, the heart, and such parts as are common to both sexes; while there are no more than what are necessary for the production of the sexual parts. Now, the similar particles may act upon each other without producing any disorder; and they may unite in the same manner as if they had proceeded from the same body. But the dissimilar particles cannot act upon each other, nor form any intimate union, because they have no analogy or relation: hence these particles will pre-

serve their original nature without any mixture, and fix their position, without the necessity of being penetrated by others. Thus the particles which proceed from the sexual parts will be first fixed, and those that are common to the two sexes, whether they belong to the male or to the female, will then fix indiscriminately, and form an organized body, which, in its sexual parts, will perfectly resemble the father, if it be a male, and the mother, if it be a female, but which, in the other parts, may resemble either or both.

If what I have advanced be properly understood, we shall, perhaps, be able to obviate an objection to the system of Aristotle, and which might also be urged against the doctrine which I am now establishing. The objection is, Why is not every individual, both male and female, endowed with the faculty of producing an animal of its own sex? I am aware of the difficulty of solving this question, which I have slightly mentioned in the fifth chapter, and shall now proceed farther to illustrate.

From what is delivered in the first four chapters, and from the experiments I have related, it is apparent, that reproduction is effected by the assemblage and union of the organic particles, detached from every part of the animal or vegetable body, in one or several common reservoirs; that these particles are the same which serve for the nutrition and expansion of the body; and that both effects are produced by the

same matter, and by the same laws. I think I have established this point by so many facts and reasonings, that it is impossible to entertain a doubt concerning its truth. But I allow, that the question may be put, Why every separate animal and vegetable produces not its own likeness, since every individual detaches from all its parts, and collects, in a common reservoir, the organic particles necessary for the formation of a small organized body? Why is not this organized body formed? and why, in most animals, is a mixture of the fluids of both sexes necessary? If I were to reply, that, in all the vegetable tribes, in all those animals that multiply by cuttings, and in the vine-fretters, which produce without any sexual commerce, the general intention of Nature seems to be, that each individual should multiply its own species, and that reproduction by the intervention of sexes is only an exception to this general law; it might, with propriety, be rejoined, that the exception is perhaps more universal than the rule itself. To maintain that all individuals would have the faculty of reproducing, if they were endowed with proper organs, and if they contained the matter necessary for nourishing the embryo, is not removing the difficulty: for, in females, all these circumstances concur; and yet the influence of the male is indispensible to the production either of a female or of a male fœtus.

But, we come nearer a solution of the question, when we maintain, that, though the fluid

in the testicles and seminal vessels of the male contain all the organic particles necessary for the formation of a male fœtus, yet these particles cannot receive any local establishment or arrangement of parts, because a constant circulation of them goes on by means of absorption, and by the perpetual succession of new supplies from all parts of the body; and that, as the same circulation of the organic particles takes place in the female, neither of them can possibly multiply without the assistance of the other; because, in the mixture of the male and female fluids, the different organic particles of which they consist have a greater affinity to each other than they have to the body of the female where the mixture happens. But, though this explication were admitted, why, it may still be asked, does not the ordinary mode of generation correspond with it? For, upon this supposition, each individual would produce, and, like snails, mutually impregnate one another, every individual receiving the organic particles furnished by the other, which, without being injured by any foreign power, would unite solely by the affinity between the particles themselves. If there were no other cause by which the organic particles could be united, perhaps this mode of generation would be the most simple. But it is contrary to the analogy of Nature. Few animals are endowed, like snails, with both sexes; and, therefore, if this mode of propagating were the most simple, it would be more generally employed by Nature. This solution, of course, amounts to no more

than a gratuitous supposition, that males produce not, solely because they have not organs proper for containing and nourishing a fœtus.

It may be still farther supposed, that the activity of the organic particles in the semen of each individual requires to be counterbalanced by the force or action of those of the other individual, in order to reduce them to a fixed state, or equilibrium, without which the formation of the fœtus cannot be effected; and that the motion of the organic particles of the female cannot be counterbalanced by any other cause than a contrary action in the organic particles received from the male. But this answer is too general to be void of obscurity. However, when we attend to all the phænomena, it may, perhaps, admit of some illustration. The mixture of the two seminal fluids produces not only a male or female fœtus, but other organized bodies, which are endowed with the faculty of growth or expansion. The placenta, the membranes, &c., are produced at the same time, if not sooner, than the fœtus. There are, therefore, in the seminal fluid of the male or female, or in the mixture of both, organic particles not only suited to the production of the fœtus, but of the placenta and membranes. Since there are no parts either in the male or female bodies from which they could be detached, whence do these particles proceed? It must be admitted, that the organic seminal particles of each sex, being equally active, uniformly produce organized bodies every time that they can fix themselves,

by their mutual action upon one another; that, of the particles destined to produce a male, those peculiar to the male sex will fix first, and form the sexual parts; that the particles common to both sexes may afterwards fix themselves indifferently, in order to form the rest of the body; and that the placenta and membranes are produced by the excess of organic particles which have not been employed in the formation of the fœtus. If, as we have supposed, the fœtus be a male, all the organic particles peculiar to the female sex, which have not been employed, as also the superfluous particles of both individuals, which have not entered into the composition of the fœtus, and which cannot be less than one half of the whole, remain for the formation of the membranes and placenta. If the fœtus be a female, the same quantity of superfluous organic particles still remain, and are occupied in forming the placenta and membranes.

But it may be said, that the membranes and placenta, upon this supposition, ought to become another fœtus, which would be a male, if the first was a female, and a female, if the first was a male; because the first fœtus consumed only the organic particles peculiar to the sex of one individual, and the half of those particles which were common to both sexes; and, of course, the sexual particles of the other individual, and the other half of the common particles, remain still unexhausted. To this I reply, that the first union of the organic particles prevents a second, at least under the same form; and that the fœtus,

being first formed, exerts an external force, which destroys the natural arrangement of the other organic particles, and throws them into that order which is necessary for the formation of the placenta and membranes.

From the experiments and observations formerly made, it is apparent, that all animated beings contain an amazing quantity of living organic particles. The life of an animal or vegetable seems to be nothing else than a result of all the particular *lives* (if the expression be admissi   of each of these active particles, whose life i   rimitive, and perhaps indestructible. Thes   ng particles we have found in every anir   d vegetable substance; and we are cert   t all these particles are equally necessary   nutrition, and, consequently, to the reproduction of animals and vegetables. That the union of a certain number of these particles, therefore, should produce an animated being, it is not difficult to conceive. As each particle is animated, a whole, or any assemblage of them, must be endowed with life. These living organic particles being common to all animated beings, they are capable of forming particular species of animals or of vegetables, according to the peculiar arrangement they assume. Now, this arrangement depends entirely on the form of the individuals which furnish the organic particles. If they are furnished by an animal, they arrange themselves under the form peculiar to its species, exactly agreeable to that arrangement they observed when they nourished or ex-

panded the animal itself. But, does not this regular arrangement suppose the necessity of some base or centre, round which the particles assemble in order to unite and form a fœtus? This basis is furnished by the particles which form the sexual parts. I shall illustrate this point.

As long as the organic particles of either sex remain alone, their activity produces no effect, because it is not opposed by any resistance or reaction from particles of a different kind. But, when the male and female liquors are blended, the particles detached from the sexual parts, being of a different kind, serve as a base to fix the activity of the other particles.

Upon this supposition, that the organic particles which, in the mixture of the two fluids, represent the sexual parts of the male, can alone serve as a basis to the particles which proceed from all parts of the female; and that those proceeding from all parts of the male can only be fixed by the particles which are detached from the sexual parts of the female; we may conclude, that the sexual parts of the male fœtus are formed by the organic particles of the father, and the rest of its body by the organic particles of the female; and, on the contrary, that the female fœtus derives nothing but its sex from the mother, and the rest of its body from the father. Boys, therefore, except in the parts which distinguish their sex, ought to resemble the mother more than the father, and girls should resemble the father more than the mother.

Considering generation by sexes under this light, we should conclude it to be the most common manner of reproduction, as it is in reality. Beings of the most perfect organization, as animals, whose bodies make a whole that is incapable of division, and whose powers are all concentrated into one point, cannot be reproduced in any other way; because they contain only particles that are perfectly similar, and cannot be united but by means of different particles furnished by another individual. But vegetables, which are less perfect in their organization, and which can be divided without destruction, are capable of being reproduced in different ways: 1. Because they contain dissimilar particles; 2. Because the form of these bodies is less fixed and determined than that of an animal, different parts may supply the functions of each other, and vary according to circumstances: the roots of a tree, when exposed to the air, push out branches and leaves; and thus the organic particles of vegetables obtain a local establishment, become fixed, and produce individuals in many different ways.

The same phænomenon is exhibited in animals whose organization is less perfect, as in the fresh water polypus, and others, which are capable of reproducing by the division of their parts. These organized bodies, instead of single animals, may be considered as bundles of organized beings united by a common membrane, as trees are composed of an infinite number of

minute trees*. The vine-fretters, which propagate individually, likewise contain dissimilar particles; because, after producing their young, they change into barren flies. Snails mutually communicate dissimilar particles to each other; and, therefore, each individual is fruitful. Thus, in every mode of generation with which we are acquainted, we find, that the necessary union of the organic particles cannot be effected but by the admixture of different particles, to serve as a common basis, and to fix or destroy their activity.

According to this general idea of sexes, we may suppose, that the distinction of sex extends through all Nature: for *sex*, in this sense, is nothing but that part of bodies which furnishes organic particles of a different kind from those of the common parts, and which serve as a basis for their union. But it is, perhaps, useless to reason on a question which can be solved at once by saying, that, as God has created sexes, animals must necessarily be produced by their intervention. We are not in a condition, as I formerly remarked, to explain *why* things exist; we are unable to explain *why* Nature almost universally employs sexes for the reproduction of animals, or *why* sexes exist. We ought, therefore, to content ourselves with reasoning concerning things as they are. If we attempt to rise higher, we lose ourselves in the regions

* See chap. ii.

of fancy, and forget the narrow limits of our capacity.

Leaving, therefore, all farther subtleties, I shall adhere to nothing that is not founded on facts and observation. I find that the reproduction of bodies is effected in many different modes: but, at the same time, I clearly perceive, that animals and vegetables are reproduced by the union of the organic particles detached from all parts of their bodies. I am certain that these active organic particles exist in the seeds of vegetables, and in the seminal fluids of animals, both male and female; and have no doubt that every species of reproduction is accomplished by the union and admixture of these particles. It is equally unquestionable, that, in the generation of man, and other animals, the organic particles of the male and female mix at the time of conception; because we often see children who resemble both father and mother: and, what confirms this theory is, that all the particles common to the two sexes mix together promiscuously, but that the particles peculiar to the sexes never mix; for we daily perceive children with eyes resembling those of the father, while their mouth and front resemble those of the mother. But we never see any such mixture of resemblances in the sexual parts; we never find, in the same individual, the testicles of the father and the vagina of the mother.

The formation of the fœtus, therefore, is effected by the mixture of the organic particles of

both sexes; and this mixture fixes or gives a local establishment to the particles, because it is made according to the laws of affinity, which take place between the different parts, and which determine the particles to arrange themselves in the same order they observed when they existed in the individuals who furnished them. The particles which proceed from the head, for example, cannot, according to these laws, take up their station in the legs, or in any other part but the head of the fœtus. All the particles are in motion when they first unite; and this motion must be round the point or centre of union. This basis or central point, which is necessary to the union of the particles, and which, by its reaction and inertia, fixes and destroys their activity, is probably the first assemblage of particles that proceed from the sexual parts, because they are the only particles in the mixture which differ from those common to both sexes.

I imagine, therefore, that, in the mixture of the two fluids, the organic particles which come from the sexual parts of the male fix themselves first, and cannot unite with those which proceed from the sexual parts of the female, because they are of a different nature, and have less affinity to each other than the particles that come from the eye, the arm, or any other part of the female. Round this centre, or point of union, the other organic particles successively arrange themselves, in the same order they formerly existed in the body from which they were derived; and, according as the particles of the one

or of the other individual most abound, or are nearer this central point, they enter in greater or less quantities into the composition of the new being, which, in this manner, is formed in the middle of a homogeneous fluid; at the same time, vessels begin to shoot, which increase in proportion to the growth of the fœtus, and furnish it with proper nourishment. These vessels, which have a peculiar species of organization, are probably formed by the excess of the organic particles that have not been admitted into the composition of the fœtus; for, as these particles are both active and furnished with a base or point of union from the organic particles peculiar to the sexual parts of the other individual, they must arrange themselves in the form of an organized body, but not in the form of another fœtus; because their position with respect to each other has been changed by the different movements of the particles which entered into the composition of the first fœtus. From the union of these superabundant particles, therefore, an irregular body must arise, which will resemble the fœtus in nothing but its growth and expansion, because, though this body be composed of the same organic active particles with the fœtus, their position and form must be different, as they were thrown aside from the centre or point of union, which served as a basis for the formation of the fœtus.

When the quantity of seminal fluid of both individuals is great, or, rather, when these liquors abound with organic particles, different centres

of attraction are formed in different parts of the mixture; and, in that case, by a mechanism similar to what has been mentioned above, several fœtuses are formed, some of them males, and others females, according as the particles of the one sex or of the other are the most active. But from the centre of attraction, two fœtuses can never originate; because two centres are requisite for this purpose. Besides, if this arrangement were to happen, no particles would be left for the formation of the placenta and membranes; because they would all be employed in constituting the second fœtus, which would necessarily be a female, if the other was a male. All that could happen in a case of this kind would be, that some of the particles common to both individuals, being equally attracted by the first centre of union, must arrive there at the same time, and produce a monster, or a fœtus with superfluous parts; or, if some of the common particles should fix at too great a distance from the centre, or be constrained by the attraction of the second, round which the placenta is formed, a monster, defective in some part, would be the consequence.

That the organic particles peculiar to the sexual parts serve for a basis or centre of union to the other particles of which the embryo is formed, I pretend not to demonstrate: but as they are the only particles which differ from the rest, it is more natural to imagine that they should answer this purpose than those which are common to both individuals.

I formerly detected the errors of those who maintained, that the heart, or the blood, were first formed. The whole is formed at the same time. We learn from actual observation, that the chicken exists in the egg before incubation. The head, the back bone, and even the appendages which form the placenta, are all distinguishable. I have opened a great number of eggs, both before and after incubation, and I am convinced, from the evidence of my own eyes, that the whole chicken exists, in the middle of the cicatrice, the moment the egg issues from the body of the hen. The heat communicated to it by incubation, expands the parts only, by putting the fluids in motion. But we have never been able to determine, with certainty, what parts of the fœtus are first fixed, at the moment of its formation.

I have always maintained that the organic particles were fixed, and that they united in consequence of their motion being suspended. Of the truth of this fact I am fully convinced; for, if the male and female semen be separately examined, we find in both a great number of moving particles; but, when these fluids are mixed, the motion of the particles is totally destroyed, and a certain degree of heat is necessary to renew their activity; for the chicken, which exists in the centre of th[illegible] cicatrice, has no motion before incubation; [illegible] twenty-four hours, or two days afterward[illegible] we begin to perceive it without the microscope, it has not the smallest appearance of motion. During the first

two or three days, the fœtus is only a small, white, mucilaginous mass, which gradually acquires consistence and magnitude. But this progress is exceedingly slow, and has no resemblance to the rapid movements of the organic particles in the seminal fluid. Besides, I maintained, not without reason, that the motion of the organic particles was entirely destroyed; for, if eggs be kept without exposing them to the degree of heat that is necessary for the expansion of the chicken, the embryo, though completely formed, will remain without any motion, and the organic particles of which it is composed will continue fixed, without being able to give life and motion to the embryo which was formed by their union. Thus, after the motion of the organic particles is stopped, and after they have united in such a manner as to form a fœtus, some external cause is still necessary to give them life and motion. This cause, or agent, is heat, which, by rarefying the fluids, obliges them to circulate: this circulation makes all the organs act; and nothing farther is necessary for the growth and expansion of the parts than the continuation of this heat.

Before the action of this external heat, there is not the smallest appearance of blood; and I never could perceive any change of colour in the vessels till about twenty-four hours after incubation. In the vessels of the placenta, which communicate with the body of the fœtus, the blood first appears. But it would seem that this blood loses its red colour, as it approaches the

body of the animal; for the chicken is entirely white; and during the first, second, and third days after incubation, we can with difficulty perceive a few red particles near the animal's body, but which seem not to make any part of it, though these red particles are destined for the formation of the heart. Thus the formation of blood is an effect produced by the motion communicated to the fluids by heat; and even this blood is formed without the body of the animal, the whole substance of which consists of a white mucilage.

The fœtus, as well as the placenta, receive the nourishment that is necessary for their expansion by a species of absorption; and they assimilate the organic particles of the liquor in which they swim: for, it is an equal impropriety to say that the placenta nourishes the animal, as that the animal nourishes the placenta. If the placenta nourished the fœtus, the former would diminish in proportion to the growth of the latter, which by no means happens; for both augment together. I have indeed observed, that, in eggs, the placenta at first grows much more in proportion than the fœtus, and, consequently, it may nourish the animal; or, rather, it conveys nourishment to the chick by means of absorption.

What we have said concerning the chicken, admits of an easy application to the human fœtus, which is formed by the union of the organic particles of the two sexes. The membranes and placenta are produced by the superabundant particles that enter not into the compo-

sition of the fœtus, which is now inclosed in a double membrane, containing also a quantity of fluid. This fluid is at first, perhaps, nothing but a portion of the seminal liquors of the father and mother; and, as the fœtus is not thrown out of the uterus, it enjoys, from the moment of its formation, as much external heat as is sufficient for its expansion. This heat communicates motion to the fluids; it gives play to all the organs; and the blood is formed in the placenta, and in the body of the fœtus, solely by the motion excited by the heat. We might even maintain, that the formation of the blood in a child is as independent of the mother as that which arises in the egg is independent of the hen that covers it, or of the furnace which heats it.

It is certain that the fœtus, the membranes, and the placenta, are all nourished and expanded by absorption; for, at first, the sac that contains the whole product of generation does not adhere to the uterus: and we have seen from the experiments of De Graaff upon female rabbits, that he made the globules which contained the fœtuses roll about in the uterus. They could receive no nourishment, therefore, but by absorbing the fluids that constantly bedew the uterus, to which they afterwards begin to adhere by means of a mucilage that gradually gives origin to small blood vessels, as shall afterwards be more fully explained.

But, to return to the formation of the fœtus, concerning which we have to make several remarks, both as to its situation, and to the differ-

ent circumstances that may prevent or alter the mode of its production.

In the human species, the semen of the male enters into the uterus, the cavity of which is considerable; and when it meets with a sufficient quantity of female semen, the two instantly mix, and the organic particles unite and form the fœtus. The whole is, perhaps, performed in a moment, especially if the two fluids be in an active state. The cavity of the uterus is the proper place for the formation of the fœtus; because the semen of the male has an easier admission into the uterus than into the Fallopian tubes or ovarium; and, as the uterus has only a small aperture, which is always shut, except when opened by the ardor of love, the materials of generation remain there in safety, unless they be disturbed by some rare and accidental circumstance. But, as the male fluid moistens the vagina, before it penetrates the uterus, and as the organic particles are exceedingly active, it may penetrate as far as the Fallopian tubes and ovarium. In the same manner, as the female fluid is already perfected in the glandulous bodies of the testicles, from which it distils and moistens the Fallopian tubes, before it descends into the uterus; and, as it may escape through the lacunæ round the neck of the uterus, it is not impossible that the mixture of the two liquors may take place in all these different places. Fœtuses, therefore, may frequently be formed in the vagina, and instantly fall out of it, having nothing proper for their retention.

They may also be sometimes formed in the Fallopian tubes; but instances of this kind must be rare.

Anatomists mention, that fœtuses have been found, not only in the Fallopian tubes, but likewise in the ovaria. M. Theroude *, a surgeon in Paris, showed to the academy a rude mass which he found in the right ovarium of a girl of eighteen years of age. Two open fissures, garnished with hair like eye-lids, were perceived in this mass. Above these eye-lids was a kind of front, with a black line in place of eye-brows. Immediately above the front, there were several hairs collected into two separate pencils, one of them about seven inches long, and the other three. Below the angle of the eye, two large, hard, white, dentes molares appeared, together with their gums: these teeth were about three lines long, and about a line distant from each other. Several other teeth appeared, situated at different distances. In the same volume †, M. Mery is reported to have found in the ovarium of a woman an upper jaw bone, with several teeth in it, so perfect that they appeared to be at least of ten years growth. In the Medical Journal, published by the abbé de la Roque ‡, we have the history of a woman, who died of her ninth child, which had been formed *in* or *near* one of the ovaria; for, from the description, it is not clear whether the child was within the

* See Mem. de l'Acad. des Sciences, tom. ii. p. 91.
† Page 244. ‡ January, 1683.

ovarium, or adjacent to it only. This fœtus was about an inch thick, and completely formed. In the Philosophical Transactions, examples are recorded of teeth, hair, and bones being found in the ovaria of women. If all these facts can be credited, the seminal liquor of the male must be supposed sometimes, though rarely, to mount up to the ovaria. But there are many considerations which render this point extremely doubtful: 1. The facts which seem to support it are few; 2. The only instance of a perfect fœtus found in the ovarium, is narrated in a very suspicious manner by M. Littre. Neither is it impossible that the seminal fluid of the female alone may sometimes produce organized masses, as moles, cists full of hair, of bones, or of flesh. Besides, if we are to believe anatomists, fœtuses may be formed in the testicles of men as well as in those of women; for, we are told by a surgeon, in the second volume of the History of the Old Academy *, that he found a fœtus, with its membranes, in which the head, the feet, the eyes, the bones and cartilages, were distinguishable, in the scrotum of a man. Were all these facts equally worthy of credit, we must necessarily adopt one of the two following hypotheses: either that the seminal fluid of each sex can produce nothing without being mixed with the other; or, that either of the fluids alone is capable of producing irregularly organized masses. If we maintain the former hypothesis, to explain the facts above

* Page 298.

related, we shall be obliged to admit, that the male fluid sometimes ascends to the ovarium, and, by mixing there with the female fluid, forms organized bodies; and also, that the female fluid, by being copiously effused in the vagina, may, in the time of coition, penetrate as far as the scrotum of the male, in the same manner as the venereal virus often reaches that part; and, consequently, that an organized body may be formed in the scrotum by a mixture of the male and female fluids. If the other hypothesis, which is the most probable, be adopted, namely, that the seminal fluid of each individual may separately produce organized masses, then all these osseous, fleshy, and hairy bodies, which sometimes appear in the ovaria of females, and in the scrotum of males, may derive their origin from the seminal fluid of the individual in which they are found. But it is needless to speculate farther concerning facts which seem to be more uncertain than inexplicable; for I am inclined to think, that the seminal fluid of each individual may singly produce something; and that young girls, for example, may produce moles, without any intercourse with the male, in the same manner as hens lay eggs without the intervention of the cock. I might support this opinion with observations equally credible as those we have just now quoted. M. de la Saone, a physician and anatomist, published a treatise on this subject, in which he assures us, that nuns, though strictly cloistered, sometimes produce moles: and why should this be impossible, since hens produce

eggs without any communication with the cock, and since we find, in the cicatrices of these eggs, instead of a chicken, a mole with its appendages? The analogy here is sufficiently strong to make us at least suspend a rash determination. Whatever be in this, it is certain, that a mixture of the two fluids is necessary for the formation of a fœtus, and that this mixture cannot be properly effected but in the uterus, or in the Fallopian tubes, where anatomists have sometimes discovered fœtuses: and it is natural to imagine, that those which have been found in the cavity of the abdomen, have escaped by the extremity of the tube, or by some accidental rupture of the uterus; and that they never fall into the abdomen from the ovarium, because I think it next to impossible that the seminal fluid should ascend so far. Leeuwenhoek has computed the motion of his pretended spermatic animals to be four or five inches in forty minutes; so that, if the whole fluid moved at this rate, in an hour or two the animalcules might proceed from the vagina into the uterus, from the uterus into the Fallopian tubes, and from the Fallopian tubes into the ovaria. But how is it possible to conceive, that the organic particles, whose motion ceases whenever they are deprived of the fluid part of the semen, should arrive at the ovarium, unless they were accompanied with the liquor in which they swim? The moving particles cannot give a progressive motion to the fluid which contains them. Thus, whatever activity may be ascribed to these organic particles, we cannot

conceive how they should arrive at the ovarium, and there form a fœtus, unless, by some unknown power, the fluid be absorbed by the ovarium, a supposition which is not only gratuitous, but contrary to probability.

The difficulty attending this supposition confirms the opinion, that the male fluid enters the uterus, either by its orifice, or by penetrating its substance. The female fluid may likewise find its way into the uterus, either by the aperture at the extremity of the Fallopian tubes, or by penetrating the substance of the tubes and uterus. M. Weitbrech, an able anatomist of the Academy of Petersburg, has clearly proved that the seminal fluid can penetrate through the substance of the uterus: "Res omni attentione dignissima," says he, "oblata mihi est in utero fœminæ alicujus a me dissectæ; erat uterus ea magnitudine qua esse solet in virginibus, tubæque ambæ apertæ quidem ad in gressum uteri, ita ut ex hoc in illas cum specillo facile possem transire ac flatum injicere, sed in tubarum extremo nulla dabatur apertura, nullus aditus; fimbriarum enim ne vestigium quidem aderat, sed loco illarum bulbus aliquis pyriformis materia subalbida fluida turgens, in cujus medio fibra plana nervea, cicatriculæ æmula, apparebat, quæ sub ligamentuli specie usque ad ovarii involucra protendebatur.

"Dices, eadem a Regnero de Graaff jam olim notata. Equidem non negaverim illustrem hunc professorem, in libro suo de organis mulieribus, non modo similem tubam delineasse, tab. xix.

fig. 3. sed et monuisse 'tubas quamvis, secundum ordinariam naturæ dispositionem, in extremitate sua notabilem semper coarctationem habeant, præter naturam tamen aliquando claudi;' verum enimvero, cum non meminerit auctor an id in utraque tuba ita deprehenderit, an in virgine, an status iste præternaturalis sterilitatem inducat, an vero conceptio nihilominus fieri possit, an a principio vitæ talis structura suam originem ducat, sive an tractu temporis ita degenerare tubæ possint, facile perspicimus multa nobis relicta esse problemata, quæ, utcumque soluta, multum negotii facescant in exemplo nostro. Erat enim hæc fœmina maritata, viginti quatuor annos nata, quæ filium pepererat quem vidi ipse, octo jam annos natum. Dic igitur tubas ab incunabulis clausas sterilitatem inducere: quare hæc nostra fœmina peperit? Dic concepisse tubis clausis: quomodo ovulum ingredi tubam potuit? Dic coaluisse tubas post partum: quomodo id nosti? quomodo adeo evanescere in utroque latere fimbriæ possunt, tanquam nunquam adfuissent? Si quidem ex ovario ad tubas alia daretur via, præter illarum orificium, unico gressu omnes superarentur difficultates; sed fictiones intellectum quidem adjuvant, rei veritatem non demonstrant; præstat igitur ignorationem fateri, quam speculationibus indulgere*. These difficulties, which occurred to this acute observer, are insurmountable, according to the egg system. But the fact he

* See Comm. Acad. Petropol. vol. iv. p. 261 and 262.

records is alone sufficient to demonstrate, that the female fluid may penetrate the substance of the uterus; and it is not to be doubted that the male fluid is capable of entering it in the same manner. The change which the male fluid produces in the uterus, and the species of vegetation or expansion which it occasions in that viscus, is sufficient to demonstrate the truth of the fact. Besides, the fluid which issues through the lacunæ of De Graaff being of the same nature with that of the glandulous bodies, it is evident that this liquor proceeds from the ovaria; and yet there are no vessels through which it could pass. We must therefore conclude, that it penetrates through the spongy substance of the parts, and that it not only enters the uterus, but may even issue out of it, when the parts are irritated.

But, though this penetration should be regarded as impossible, it cannot be denied, that the female fluid, which distils from the glandulous bodies of the ovaria, may fall into the uterus, by entering the apertures at the extremities of the Fallopian tubes, as the male fluid enters by the orifice of the uterus itself; and, consequently, that the fœtus may be formed in the cavity of the uterus, by the mixture of the two fluids, in the manner already explained.

CHAP. XI.

Of the Expansion, Growth, and Delivery of the Fœtus, &c.

IN the expansion of the fœtus, two different species of growth are distinguishable: the first, which immediately succeeds the formation of the fœtus, is not uniform in all the parts of the animal. The nearer the fœtus approaches to maturity, the growth of the parts is more proportional; and it is not till after the birth, that all the parts grow nearly in an equable manner. We must not imagine, that the fœtus, at the time of its formation, has the exact figure of an adult. The small embryo, it is true, contains all the parts essential to a man; but they differ in their successive expansion.

In an organized body, like that of an animal, some parts may be supposed to be more essential than others; and though none of them are useless or superfluous, yet there are some to which others seem to owe their growth and disposition. Some parts may be considered as fundamental, without which the animal could not exist, and others as only superficial and accessory. The latter seem to derive their origin from the former, and to be intended more for conferring symmetry and external ornament on the animal, than

for enabling it to exist, or to perform the functions essential to life. These two different species of parts are successively expanded, and are almost equally apparent at the time of birth. But there are other parts, as the teeth, which arrive not at full maturity till several years after; and others, as the glandulous bodies in the female testicles, the beard of males, &c., which appear not till the age of puberty.

To discover the fundamental and essential parts of an animal body, attention must be had to the number, situation, and nature of the whole. Those which are simple, those whose position is invariable, and those without which the animal cannot exist, must necessarily be the most essential. Those, on the contrary, which are double, or more numerous, those which vary in size and position, and those which may be taken away without injuring or killing the creature, may be regarded as less essential, or more accessory to the animal machine. Aristotle mentions, that the only parts essential to all animals are those with which they take and digest their nourishment, and throw out the superfluous part of it from the body. The whole intestinal canal is indeed extremely simple, and no other part can supply its place. The head and back bone are likewise simple parts, the position of which is invariable. The back bone is the foundation of the animal frame; and the action and movements of most members of the body depend upon the spinal marrow which that bone contains. It is this part, also, together with the head, which appears

first in the embryo. Now, these simple parts, which are first formed, are all essential to the existence and the form of the animal.

The double parts in an animal body are more numerous than the single parts; and they seem to be produced on each side of the single parts by a species of vegetation; for the double parts are similar in form, and different only in position. The left hand is perfectly similar to the right; but, if the left hand were placed in the situation of the right, we could not perform the same actions with it. The same thing may be observed of all the double parts: they are similar in form, but differ in position, which is relative to the body of the particular animal; and, if a line were drawn, dividing the body into two equal parts, the position of all the similar parts would tend to this line as to a centre.

The spinal marrow, and the vertebræ in which it is inclosed, appear to be the real axis of all the double parts of the animal body, from which they seem to derive their origin, and to be only proportional branches issuing from this trunk or common base; for, in the young chick, we see the ribs shooting from each side of the vertebræ, as the small branches shoot out from the principal branch of a tree. In all embryos, the middle of the head and the vertebræ first appear; we then see, on each side of the vesicle which composes the middle of the head, two other vesicles, which seem to proceed from the first: those two vesicles contain the eyes, and the other double parts of the head. In the same manner,

we perceive an equal number of small tubercles issuing from each side of the vertebræ, which gradually extend and form the ribs, and other double parts of the trunk. Lastly, the arms and legs appear like small tubercles on each side of the trunk. This first growth is very different from what afterwards takes place: it is the production of parts which appear for the first time; the growth which succeeds is only an expansion of parts already formed.

The order and symmetry of the double parts in all animals, their regular position, the equality of their extension and growth, and the perfect similarity of their structure, seem to indicate, that they derive their origin from the single parts; that a certain force resides in the single parts, which acts equally on each side; or, which amounts to the same, they are the bases or fulcra against which the action of those powers that produce the expansion of the double parts is exerted; and that the action of these forces, both on the right and left sides, are precisely equal, and counterbalance each other.

Hence we may conclude, that, if there is any defect or redundance of the matter destined for the formation of the double parts, as the forces are equal on each side, this defect or excess must take place both in the right and left sides. If, for example, from a defect of matter, a man has but two fingers in the right hand, in place of five, the same defect will appear in the left; if, from an excess of matter, there be six fingers in the right hand, he will have the same

number in the left; or, if the matter be vitiated, and produces a change in the parts of one side, the same change will appear in the other. Of this fact we have daily proofs: the parts of monsters are always deranged in a certain order and proportion. Hence Nature, even in her errors, uniformly commits the least of possible mistakes.

This harmony in the position of the double parts of animals, is likewise apparent in vegetables. The branches push out small ramifications on each side; the small nerves in the leaves are equally disposed with regard to the principal nerve; and, if the symmetry appears to be less exact in vegetables than in animals, this proceeds only from its being more various, and because its limits are more extensive, and less precise. But the same order is easily recognisable; and the single and essential parts are perfectly distinct from those which are double; and it is evident, that the latter derive their origin from the former.

It is impossible to determine the form of these double parts before their expansion, or in what manner they are complicated, or what figure results from their position in relation to the single parts. The body of an animal, at the instant of its formation, unquestionably contains all the parts of which it ought to be composed: but the relative disposition of these parts is then very different from what afterwards appears. If we examine the expansion of a young leaf of a tree, we shall find that it is plaited on each side

of the principal nerve; and that its figure, at this time, has no resemblance to that which it afterwards assumes. When we amuse ourselves with plaiting paper, in order to give it the form of a crown, of a boat, &c., the different plaits of the paper seem to have no resemblance to the figure which results from their expansion: we only perceive that the plaits are uniformly made in a certain order and proportion, and that, whatever is done on one side, is also done on the other. But, to determine the figures which may result from the expansion of any given number of folds, is a problem beyond the powers of geometry. The science of mathematics reaches not what immediately depends upon position. Leibnitz's art of *Analysis situs* does not yet exist; though the art of knowing the relations that result from the position of things would be, perhaps, more useful than that which has magnitude only for its object; for we have more occasion to be acquainted with form than with matter.

In the expansion of natural productions, the folded or plaited parts not only assume different positions, but they acquire, at the same time, extension and solidity. Since, therefore, we are unable to ascertain the exact result of a simple expansion of a folded figure, in which, as in folded paper, nothing takes place but a change of position among the parts, without any augmentation or diminution of the quantity of matter, how is it possible for us to judge concerning the expansion of the compound body of an animal, in which not only the relative posi-

tion, but likewise the quantity of matter in these parts, suffer considerable changes? We can only reason, therefore, on this subject, by drawing conclusions from the examination of objects at different periods of their expansion.

We, indeed, perceive the chick in the egg before incubation: it swims in a transparent fluid, contained in a small purse formed by a very fine membrane in the centre of the cicatrice. But the chick is then only a particle of inanimated matter, in which no organization or determined figure can be distinguished. We can perceive, however, that one of its extremities is the head, and the other the back bone. The embryo, in this state, seems to be the first product of fecundation, resulting from the mixture of the male and female semen. To ascertain this fact, several things require attention: when the hen has, for some days, been along with the cock, and afterwards separated from him, the eggs produced twenty days or a month after this separation, are equally fertile as those laid during her cohabitation with the male. The eggs produced at the end of this period require only the usual time of twenty-one days in hatching; and their embryos are equally advanced both in form and consistence. From this circumstance we might be led to imagine, that the form in which the embryo appears before incubation, is not the immediate effect of the mixture of the two seminal fluids, but that it existed in different forms during the abode of the egg in the body of the mother; for the embryo, in the form in which

we see it before incubation, requires only the aid of heat in order to bring it to maturity. Now, if this form of the embryo had existed twenty-one days or a month before, when the egg was first impregnated, why was it not hatched by the internal heat of the mother? Why do we not find the chick completely formed in those eggs which have been impregnated twenty-one days before they are laid?

But this difficulty, though seemingly great, is not insurmountable. When the hen cohabits with the cock, the cicatrice of each egg, which contains the semen of the female, receives a small quantity of the male fluid. The eggs in the ovarium of oviparous females are analogous to the glandulous bodies in the testicles of the viviparous: the cicatrice of the egg corresponds to the cavity of those glandulous bodies which contain the female semen; and that of the male penetrates and mixes with it. The formation of the embryo instantly results from this mixture or union of the two fluids. The first egg laid by the hen after her communication with the cock is fecundated, and capable of being hatched. Those which she is afterwards to lay were all impregnated at the same instant: but, as they want some essential parts, the production of which has no dependance on the male fluid; as they have neither the white, the membranes, nor the shell, the small embryos contained in the cicatrices of these imperfect eggs are incapable of being hatched, though aided by the internal heat of the mother. The embryo, there-

fore, remains in the cicatrice in the same state in which it was first formed, till the egg acquires all the parts necessary to the growth and nourishment of the fœtus; and it is not till after the egg has arrived at full perfection, that the expansion of the embryo commences. This expansion is effected by the external heat of incubation: but it is unquestionable, that, if the egg could be retained in the body twenty-one days after it was completely formed, the chick would be hatched, unless the internal heat of the mother were too great; for the degrees of heat necessary for hatching eggs are very limited; and the least excess or defect is equally fatal to this operation. The last eggs, therefore, laid by the hen, containing the embryos in the same state as the first, prove nothing more than the necessity of their acquiring full perfection before they can be hatched.

It is apparent, therefore, that the state of the embryo when the egg is laid by the hen, is its first state, and that which immediately succeeds impregnation; that it undergoes no intermediate changes of form; and, consequently, by tracing, as Malpighius has done, its gradual expansion, hour after hour, we discover every thing that it is possible for us to know, unless we could perceive the mixture of the two fluids, and the manner in which the particles arrange themselves during the first motion of the embryo.

If we reflect on this instantaneous fecundation of a number of eggs, which are to be laid at suc-

cessive intervals, we shall discover a new argument against the existence of eggs in viviparous animals: for if women contained eggs, like hens, why are not many of them fecundated at the same time? Why does not one impregnation give birth to a successive race of children? And, when women conceive two or three children, why do they always come into the world at the same time? If these fœtuses were produced from eggs, would they not succeed each other according to the different states of perfection of the several eggs existing at the time of impregnation? And would not superfœtations be as frequent as they are rare, and as natural as they are accidental.

It is impossible to trace the gradual expansion of the human fœtus, as we can that of the chick in the egg. The opportunities for observation are few; and all we know of this subject is derived from the writings of anatomists, surgeons, and accoucheurs. It is from collecting all their particular observations, and comparing their remarks with their descriptions, that the following abridged history of the human fœtus has been compiled.

Immediately after the mixture of the two seminal fluids, it is probable that the whole materials of generation exist in the uterus, under the form of a small globe; for we learn from anatomists, that, three or four days after conception, there is a small globular mass in the uterus, the greatest diameter of which is about six lines, and the least four. This globe is formed by a deli-

cate membrane, which contains a limpid liquor, very like the white of an egg. We may already perceive, in this liquor, some small fibres, which are the first rudiments of the fœtus. Upon the surface of the globe there is a net-work of delicate fibres, which extend from one of the extremities to the middle: these are the first vestiges of the placenta.

Seven days after conception, the lineaments of the fœtus are distinguishable by the naked eye. They are, however, very imperfect, and have the appearance of a gelly almost transparent, though it has acquired some degree of solidity. The head and trunk may be easily distinguished; because this mass is of an oblong figure, and the trunk is longest and most delicate. Some small fibres, resembling a plume of feathers, issue from the middle of the fœtus, and terminate in the membrane in which it is inclosed. These fibres are the rudiments of the umbilical cord.

Fifteen days after conception, the head and the most prominent features of the face are apparent. The nose resembles a small elevated thread perpendicular to a line which marks the division of the lips: two small black points represent the eyes; and we see two holes in place of ears. The body of the fœtus has also acquired some growth. On each side of the superior and inferior parts of the trunk, those small protuberances appear, which are the rudiments of the arms and legs. The length of the whole body is about five French lines.

Eight days after, in all three weeks, the body of the fœtus is augmented only about a line: but the arms and legs are apparent. The growth of the arms is quicker than that of the legs; and the fingers separate sooner than the toes. The internal organization now begins to be visible: the bones appear like fine threads. The ribs are disposed on each side of the back bone like minute threads: the arms, the legs, the fingers, and toes, are also represented by similar threads.

At one month, the fœtus is more than an inch in length: it naturally assumes a curved posture in the middle of the liquor that surrounds it; and the membranes in which the whole is included, are both augmented and thickened. The whole mass is of an oval figure, the greatest diameter of which is about an inch and a half, and the least about an inch and a quarter. The human figure is no longer equivocal: all the parts of the face are already distinguishable; the body is delineated; the haunches and the belly are prominent; the hands and legs are formed, and their fingers and toes are divided; the skin is thin and transparent; the viscera resemble a knot or plexus of fibres; the vessels are like fine threads, and the membranes are extremely delicate; the bones are still soft, and it is in a few places only that they have begun to assume some degree of solidity. The vessels which form the umbilical cord lie parallel to each other in a straight line. The placenta now occupies only a third of the whole

mass, instead of a half, which it did during the first days; the superficial growth of the placenta, therefore, has not been so great as that of the fœtus and mass; but it has received a great augmentation in solidity; it has become proportionally thicker than the membranes of the fœtus, both of which are now distinguishable.

According to Hippocrates, the male fœtus expands sooner than the female.

At the end of six weeks, the fœtus is about two inches long, and the human form begins to be more perfect, only the head is very large in proportion to the other parts of the body. About this time the motion of the heart becomes visible: in fifty days the heart has been perceived to beat for a considerable time after the fœtus was extracted from the uterus.

In two months, the fœtus is more than two inches in length; and the ossification is perceptible in the middle of the two arm bones, in the thigh and leg, and in the point of the under jaw, which is then greatly advanced before the upper. These, however, are only osseous points. But, by means of a quicker growth, the clavicles are entirely ossified: the umbilical cord is formed, and the vessels which compose it begin to twist like the threads of a rope: but this cord is very short in comparison of the length it afterwards acquires.

In three months the fœtus is nearly three inches long, and weighs about three ounces. Hippocrates asserts, that at this time the motions of the male fœtus begin to be felt by the mo-

ther; but that those of the female are not perceptible till four months. Some women, however, affirm, that they have felt the motions of the fœtus at the beginning of the second month. It is difficult to acquire any certain knowledge on this subject: the sensations excited by the first movements of the fœtus depend more, perhaps, on the sensibility of the mother, than the strength of the child.

Four months and a half after conception, the length of the fœtus is from six to seven inches. All the parts are greatly augmented, and easily distinguishable from each other: even the nails appear on the fingers and toes. The testicles of the male are shut up in the belly above the kidneys. The stomach is filled with a thick fluid, similar to that which is contained in the amnios. In the small guts we find a milky fluid, and a black liquid matter in the great guts. There is a small quantity of bile in the vesica fellis, and a little urine in the bladder. As the fœtus floats freely in the fluid that surrounds it, there is always some space between its body and the membranes in which it is contained. These membranes, at first, grow more rapidly than the fœtus: but, after a certain time, the reverse takes place. Before the end of the third month, the head is bent forward; the chin rests on the breast; the knees are elevated, and the legs folded back upon the thighs. One of the hands, and often both, touch the face. Afterwards, when the fœtus acquires more strength, it perpetually changes its position, as we learn from

the following observations made by persons skilled in the art of midwifery: 1. The umbilical cord is often twisted round the body and members of the child, in a manner that necessarily supposes different motions and positions. 2. Mothers feel the motion of the child sometimes on one side of the uterus, and sometimes on the other; and it often strikes against many different places, which could not happen unless it assumed different positions. 3. As the fœtus swims in a fluid which surrounds it on all sides, it may easily turn, extend, and twist itself by its own powers: it must likewise take different situations, according to the various attitudes of the mother's body; when the mother, for example, lies down, the position of the fœtus must differ from what it is when she stands.

Most anatomists maintain, that the fœtus is obliged to bend its body, because it is too much confined by the membranes. But this opinion seems not to be well founded; for, during the first five or six months, at least, there is room more than sufficient to admit a full extension of the fœtus; and yet, during all this period, the fœtus is bended. We see likewise that the chick is bended in the liquor of the amnios, while, at the same time, this membrane, and the fluid it contains, afford room sufficient to hold a body five or six times larger than the fœtus. We may, therefore, conclude, that the bended posture of the fœtus is natural, and not the effect of restraint. I am inclined to think, with Harvey, that the fœtus takes this posture, be-

cause it is most favourable to rest and sleep; for all animals bend their bodies when they want to repose themselves, or to sleep: and, as the fœtus sleeps almost continually, it naturally assumes this advantageous position. "Certe," says this celebrated anatomist, "animalia omnia, dum quiescunt et dormiunt, membra sua ut plurimum adducunt et complicant, figuramque ovalem ac conglobatam quærunt: ita pariter embryones, qui ætatem suam maxime somno transigunt, membra sua positione ea qua plasmantur (tanquam naturalissima ac maxime indolenti quietique aptissima) componunt *."

The uterus, as formerly remarked, grows very quickly after pregnancy; and it continues to increase proportionally with the fœtus. But the growth of the fœtus at last exceeds that of the uterus; and it is natural to think, that the fœtus, when near maturity, is too much confined, and agitates the uterus by repeated motions. The mother feels these successive efforts, which are called periodic pains, after the labour of child-bearing commences. The more force the fœtus exerts in order to dilate the uterus, it finds an increased resistance from the natural elasticity of the parts. Hence every effort tends to open the os tincæ, or orifice of the uterus, which has already been gradually enlarged during the last months of pregnancy. The head of the fœtus pushes along against the margins of this orifice, and dilates it by a con-

* Harvey de Generat. p. 257.

stant pressure, till the moment of delivery, when it opens so wide as to allow a free passage to the child.

What renders it probable that the labour-pains are occasioned by the dilatation of the os tincæ is, that this dilatation is the only certain mode of distinguishing the real from the false pains. Women often feel very brisk pains, which are not those that immediately precede delivery. To distinguish those false from the true pains, Deventer advises the accoucheur to feel the orifice of the uterus, and maintains, that, if the pains be true, the dilatation will augment upon the accession of every pain; and that, on the contrary, if the pains be false, the orifice will rather contract than dilate, or, at least, that it will not continue to dilate. Hence we may conclude, that these pains proceed not from a forced dilatation of the orifice of the uterus. The only thing that is embarrassing, is the alternation of pain and of ease experienced by the mother. This circumstance does not perfectly correspond with the cause we have assigned; for the gradual and continued dilatation of an orifice should produce a constant pain, without any intervals of ease. Perhaps the alternations may be ascribed to the separation of the placenta: it adheres to the uterus by the insertions of a number of small papillæ. May we not, therefore, suppose that these papillæ separate not from their cavities all at once; and that the successive separation of these papillæ gives rise, at different intervals, to the fresh accessions of

pains? Here the effect perfectly corresponds with the cause; and this conjecture may be supported by another remark: immediately before delivery, there issues out a viscous whitish liquor, similar to that which flows from the papillæ of the placenta, when torn from the uterus. It is therefore extremely probable, that this liquor, which issues from the uterus, is produced by the separation of some of the papillæ of the placenta.

It sometimes happens, that the fœtus escapes from the uterus, without bursting the membranes, and, consequently, without discharging the liquor they contain. This species of birth seems to be the most natural, and is similar to that of most animals. The human fœtus, however, commonly pierces the membranes, by the resistance it meets with at the orifice of the uterus. And sometimes a part of the amnios, and even of the chorion, is brought away adhering to the head of the child like a cap. As soon as the membranes are pierced or torn, the liquor, which is called the *waters*, runs out, and, by lubricating the vagina and orifice of the uterus, facilitates the passage of the child. After the discharge of the waters, there is sufficient room left in the uterus for the midwife to return the child, when its position is unfavourable to the birth. After the child comes into the world, the delivery is not completed. The placenta and membranes still remain in the uterus; and the child is attached to them by means of the umbilical cord: they are easily brought

away by the hand of the midwife; and sometimes the weight of the child is sufficient. These organs, which were necessary to the existence of the fœtus, become useless, and even noxious to the child, after birth. They are, therefore, instantly disengaged from the child's body, by casting a knot on the umbilical cord, about an inch from the navel, and by cutting the cord an inch above the ligature. In six or seven days, the remains of the cord dry up, and fall off close to the navel.

By examining the fœtus before birth we are enabled to form some ideas concerning the mechanism of its natural functions. There are organs necessary to it while in the womb of the mother, but which become useless immediately after birth. The better to comprehend these functions, we must explain more fully the nature of these accessory parts, the umbilical cord, the membranes, with the liquor they contain, and the placenta. The umbilical cord, which is attached to the body of the fœtus at the navel, is composed of two arteries and a vein: by these the course of the circulation is lengthened; but the vein is larger than the arteries. At the extremity of the cord, each of these vessels divide into an infinite number of ramifications, and extend themselves between two membranes. They set off from the common trunk in such a manner, that the whole ramifications assume a round form, and are distinguished by the name of placenta, because they resemble a cake. The central part of the placenta is thicker than its

edges: its mean thickness is about an inch, and its diameter is eight or nine inches, and sometimes more. Its external surface, which is applied to the uterus, is convex, and the internal surface is concave. The blood of the fœtus circulates in the cord and in the placenta. The arteries of the cord proceed from two large arteries in the fœtus, and carry the blood through all the arterial ramifications of the placenta; and the blood is collected and returned to the fœtus by the venous branches of the placenta and the umbilical vein.

The concave surface of the placenta is covered with the chorion: its convex surface is also covered with a soft membrane, which seems to be a continuation of the chorion, and is easily torn; and the fœtus is inclosed in the double covering of the chorion and amnios. The figure of the whole is globular, because the intervals between the fœtus and membranes are filled with a transparent fluid. This liquor is immediately confined by the amnios, which is the internal membrane: it is thin and transparent, and folds itself round the umbilical cord, at its insertion into the placenta, and continues to cover it the whole way to the navel of the fœtus. The chorion is the external membrane; it is thick, spongy, and interspersed with blood vessels. It consists of several coats, the outermost of which covers the convex surface of the placenta. It sends off duplicatures to cover the papillæ, which are inserted into the cavities at the

fundus of the uterus, called *lacunæ*. These insertions connect the fœtus to the uterus.

Some anatomists have maintained, that the human fœtus, like those of certain quadrupeds, was furnished with an *allantois*, a membrane destined for the reception of the urine; and they have pretended to have discovered it between the chorion and amnios, or in the middle of the placenta, at the root of the umbilical cord, under the form of a pretty large bladder; and that it received the urine by means of a long tube, which made a part of the cord, and which opened at one end into the bladder, and at the other into the allantois, answering the same purposes as the urachus in other animals. They acknowledge, however, that the urachus of the human fœtus is not near so large as in quadrupeds; but they assert that it is divided into a number of small tubes, and that the urine passes into their cavities.

To these facts are opposed the experience and observation of most anatomists. They seldom find any vestiges of an allantois, either between the chorion and amnios, or in the placenta; nor do they perceive any urachus in the umbilical cord. A kind of ligament,, indeed, runs from the external surface of the bottom of the bladder to the navel; but, when entering the cord, it becomes so delicate as to be almost reduced to nothing. Neither is this ligament commonly hollow; and we can perceive no corresponding aperture in the bottom of the bladder.

The fœtus has no communication with the open air; and the experiments made upon the lungs demonstrate that they have never respired; for they sink in water, while those of infants, who have breathed, uniformly swim: the fœtus, therefore, has no respiration in the womb of the mother; consequently, it can make no sound with its voice; and all the stories of children groaning and crying before birth must be regarded as fabulous. After the waters run off, however, the air may find admission into the cavity of the uterus, and the child may begin to respire before its birth. In this case, the child may cry, in the same manner as the chicken cries before the shell of the egg is broken, which it is enabled to do by means of the air lodged in a cavity between the external membrane and the shell: this air exists in all eggs, and is produced by the fermentation of the matters they contain *.

The lungs of the fœtus, having no motion, receive no more blood than is sufficient for their nourishment and growth: another passage, therefore, is open for its circulation. The blood in the right auricle of the heart, instead of passing into the pulmonary artery, and, after circulating through the lungs, returning into the left auricle by the pulmonary vein, passes directly from the right to the left auricle, through an aperture called the *foramen ovale*, which is in the partition of the heart, that separates the two

* See Vegetable Statics, chap. vi.

auricles: the blood then enters the aorta, by the ramifications of which it is distributed to every part of the body; it is then taken up by the numerous branches of the veins, which gradually unite into one trunk, called the *vena cava*, that terminates in the right auricle of the heart. The blood contained in this auricle does not all pass through the foramen ovale; part of it escapes into the pulmonary artery, but it enters not into the body of the lungs; for there is a communication between the pulmonary artery and the aorta, by an arterial canal which leads immediately from the one to the other. It is by these means that the blood circulates in the fœtus, without entering the lungs, which it does in children, in adults, and in all animals who respire.

It has been imagined by some, that the blood of the mother passes into the body of the fœtus, by means of the placenta and umbilical cord: they supposed, that the blood vessels of the uterus opened into the lacunæ, and those of the placenta into the papillæ, and that they inosculated with one another. But this opinion is contradicted by experiment. When the arteries of the umbilical cord are injected, the liquor returns by the veins, without any of it escaping externally. Besides, the papillæ can be drawn out of the lacunæ in which they are lodged, without any extravasation of blood either from the uterus or placenta; from both there oozes out a milky matter, which, we have already remarked, serves for the nourishment of the fœ-

tus. It is probable that this liquor enters the veins of the placenta in the same manner as the chyle enters the subclavian vein; and the placenta, perhaps, performs the office of the lungs in maturating the blood. One thing is certain, that the blood appears much sooner in the placenta than in the fœtus; and I have often observed, in eggs which had been sat upon for a day or two, that the blood appeared first in the membranes, and that their blood vessels are numerous and large, while the whole body of the fœtus, except the point where these blood vessels terminate, is only a white transparent matter, in which there is not the least vestige of blood.

It has been imagined that the liquor of the amnios is a nourishment received by the mouth of the fœtus. Some have even pretended to have found this liquor in the stomach, and to have seen several fœtuses who wanted the umbilical cord entirely, and others who had only a small portion of it, which had no connexion with the placenta. But, in this case, may not the liquor have passed into the body of the fœtus by the portion of the cord that remained, or even by the navel itself? Besides, other facts may be opposed to these: fœtuses have been found, whose lips were not separated; and others whose œsophagus had no aperture. To reconcile these facts, some anatomists have maintained that the aliment passed into the fœtus partly by the umbilical cord, and partly by the mouth. But none of these opinions seem to have any foundation. The question is not how

the fœtus alone, but how the whole apparatus of generation, receive their growth and nourishment? For the placenta, the liquor, and the membranes, increase in bulk as well as the fœtus; and, consequently, those instruments and canals employed for receiving and transporting nourishment to the fœtus, are themselves endowed with a species of life. The expansion of the placenta and membranes is equally difficult to conceive as that of the fœtus; and, it may be said, with equal propriety, that the fœtus nourishes the placenta, as that the placenta nourishes the fœtus. At the commencement of growth, the whole mass floats in the uterus, without any adhesion; and, of course, the nourishment can only be conveyed by an absorption of the lacteous fluid contained in the uterus. The placenta appears first to attract this fluid, which it converts into blood, and transports by the veins into the fœtus. The *liquor amnii* seems to be nothing but this milky fluid in a purified state, the quantity of which is augmented, by a similar absorption, in proportion to the growth of the membranes; and the fœtus probably absorbs this liquor, which seems to be necessary for its growth and nourishment: for, it is worthy of remark, that the fœtus, during the first two or three months, contains very little blood: it is as white as ivory, and appears like a congeries of lymph somewhat consolidated; and, as the skin is transparent, and all the parts extremely soft, the body of the fœtus may be easily penetrated by the fluid in which it swims, and thus

receive the matter necessary for its growth and expansion. It may indeed be supposed that the fœtus afterwards receives nourishment by the mouth; because we find a liquor similar to that of the amnios in the stomach, urine in the bladder, and meconium, or excrement, in the intestines; and, as neither urine nor meconium appear in the amnios, it is natural to conclude, that no excrements are voided by the fœtus, especially as some are born without having the anus perforated, and yet large quantities of meconium are found in their intestines.

Though the fœtus has no immediate connexion with the uterus, but is only attached to it by the small external papillæ of the placenta; though it has no communication with the blood of the mother, but, in some measure, is equally independent of her as the egg is independent of the hen which covers it; yet it has been maintained, that, whatever affects the mother, produces a similar effect upon the fœtus, and that the impressions received by the former are communicated to the sensorium of the latter. To this imaginary influence have been attributed all those resemblances, monstrosities, and peculiar marks which appear on the skin of particular children. Many of these marks I have examined, and they uniformly appeared to be occasioned by a derangement in the texture of the skin only. Every mark must necessarily have a faint resemblance to something or other: but such resemblances, I am persuaded, depend more on the imagination of those who see them, than

upon that of the mother. On this subject, the marvellous has been pushed to an extreme degree. The fœtus has not only been said to bear the real representations of the appetites of the mother, but that, by a singular sympathy, the marks which represent strawberries, cherries, &c., assumed a deeper colour during the season of these fruits. A little attention, however, will convince us, that these changes of colour are more frequent, and that they happen whenever the motion of the blood is accelerated, whether it be occasioned by the heat of summer, or by any other cause. The marks are always either yellow, or red, or black; because the blood gives these colours to the skin when it enters in too great quantities into the vessels. If these marks were occasioned by the appetites of the mother, why are not their forms and colours as various as the objects of her desires? What a multitude of strange figures would be exhibited, if all the whimsical longings of a mother were written upon the skin of the child!

As our sensations have no resemblance to the objects which excite them, it is impossible that desire, fear, horror, or any other passion or emotion, can produce real representations of objects by which they are occasioned. An infant being, in this respect, equally independent of the mother as the egg is independent of the hen that sits upon it, I should be equally induced to believe that the imagination of a hen, which saw by accident a cock's neck twisted, should produce wry-necked chickens from the eggs she

was hatching, as that a woman that saw a man broke upon the wheel, should produce, by the mere force of imagination, a child with all its limbs broken.

But, supposing this fact to be well attested, I still maintain that the imagination of the mother could not be the cause of it: for what is the effect of horror? An intern[illegible]ment, or, if you please, a convulsion of [illegible]other's body, which might alternately co[illegible] and stretch the uterus. What would be the result of this commotion? Nothing similar to its cause; for if the commotion was very violent, the fœtus might be killed, wounded, or have some of its parts deranged: but how is it possible to imagine that this commotion should produce in the fœtus any thing similar to the thoughts of the mother, unless we suppose, with Harvey, that the uterus possesses the faculty of conceiving ideas, and of realizing them upon the fœtus?

But, if the imagination of the mother has no effect upon the fœtus, it may still be demanded, Why did this child come into the world with its members broken? Though a direct solution of a fact, which is both extraordinary and uncertain, is not to be expected; yet, I think, this question admits of a satisfactory answer. Phænomena of the most uncommon kind, and which are but rarely exhibited, as necessarily happen as those that are usual and frequent. Among the infinite combinations of which matter is capable of forming, arrangements of the most peculiar and extraordinary species must sometimes

take place. Hence, out of the numberless children which daily come into the world, one may sometimes appear with two heads, with four legs, or with all its members broken. It is, therefore, within the circle of nature, that a child, without the aid of the mother's imagination, may be born with its arms and legs broken. This pl[illegible] may have been exhibited oftener th[illegible] mother of this child may, during her [illegible]ey, have seen a man broken on the wheel [illegible] the defects of conformation in the child may have been attributed to the impulse made, by this dreadful spectacle, upon the imagination of the woman. But, independent of this general solution, the fact may be explained in a more direct manner. The fœtus, as formerly remarked, has nothing in common with the mother. Its functions, its organs, its blood, its movements, are all peculiar, and belong to itself alone. The only matter it derives from the mother, is the liquor or nutritive lymph which distils from the uterus. If this lymph suffers any change, if it be infected with the venereal virus, the infant is affected with the same disease; and it is reasonable to think that all the diseases which proceed from vitiated humours may be communicated from the mother to the child. We know that the small pox is communicated in this manner; and we have too many examples of children, immediately after birth, becoming innocent victims of the debauchery of their parents. The venereal virus attacks the most solid parts of the bones; and it appears to

act with more force upon the middle of the bones, which is the part where the ossification first commences, and is, of course, the most hard and solid part. I conceive, therefore, that the infant in question has been affected with the venereal disorder while in the womb of its mother, and that this was the reason why it came into the world with its bon[illegible]ugh the middle.

The same effect might b[illegible]ced by the rickets: in the Royal Cabinet [illegible] is a skeleton of a rickety child, the bones of whose legs and arms are joined in the middle by a callus: from inspecting this skeleton, it appears that its bones have been broken before birth, and afterwards re-united by a callus.

But we have dwelt too long upon a fact which credulity alone has rendered marvellous. Prejudice, especially that species of it which is founded in wonder, will always triumph over reason. It is needless to attempt to persuade women that the marks on their children have no connexion with their ungratified longings. I have sometimes asked them, before the birth of a child, of what particular longings they had been disappointed, and, of course, what marks the child would bear? But I had only the satisfaction of perplexing, without convincing them.

The time of gestation is generally about nine months, but it is sometimes longer and sometimes shorter. Many children are born in the seventh and eighth, and some not till after the

ninth month: but, in general, the births before the ninth month are more frequent than those which exceed that term.

It is generally believed, that children born in the eighth month cannot live, or, at least, that more of them die than of those who come into the world in the seventh month. This opinion appears to be paradoxical; and, if we consult experience, I believe it will be found to be erroneous. A child born in the eighth month is more perfectly formed, and consequently more vigorous and lively, than one who is born in the seventh. This opinion, however, is very commonly received, and is founded on the authority of Aristotle: "Cæteris animantibus ferendi uteri unem est tempus, homini vero plura sunt; quippe et septimo mense et decimo nascitur, atque etiam inter septimum et decimum positis; qui enim mense octavo nascuntur, *etsi minus*, tamem vivere possunt*." The beginning of the seventh month is the earliest term of delivery. If the fœtus be rejected sooner, it dies, and is denominated an abortion. Thus the time of gestation is more various in the human species than in other animals; for it extends from the seventh to the tenth, and, perhaps, to the eleventh month.

We are assured by women who have had many children, that females remain longer in the womb than males. If this be true, it is not surprising that female children should sometimes be

* Vide de Generat. Anim. l. iv. c. ult.

born in the tenth month. When infants come into the world before the ninth month, they are neither so large nor so well formed as those who appear not till a later period. Those, on the contrary, who remain in the womb till the tenth month, are larger and better made; their hair is longer; the growth of the teeth, though still concealed within the gums, is more advanced; and the tone of their voice is deeper and more distinct.

With regard to the occasional causes of delivery, there is much uncertainty. It is imagined by some writers, that, when the fœtus has acquired a certain size, the capacity of the uterus becomes too small for its retention, and that the restraint felt by the child obliges it to exert every effort to break its prison. Others allege, which amounts nearly to the same thing, that the fœtus becomes too heavy to be supported by the uterus, which therefore opens, to be discharged of its load. Neither of these reasons appear to be satisfactory; the uterus has always sufficient capacity and strength to contain and support the weight of a child of nine months; for it is often loaded with two, during the same period; and it is certain, that the weight and size of two children of eight months, for example, exceed those of a single infant of the same age. Besides, it is not unfrequent that a child of nine months is less than another at eight months, though it still remains in the womb.

Galen pretends that the fœtus continues in the uterus till it is able to take nourishment by

the mouth, and that the want of proper food makes it restless, and anxious to escape. It has been said by others, that the fœtus is originally nourished by the mouth, but that, in process of time, the liquor amnii is so contaminated with the urine and transpiration of the fœtus, that it becomes perfectly disgustful, and obliges the child to use every method to effect its escape from the womb.

These reasons seem not to be more satisfactory than the former; for from them it would follow, that the smallest and weakest fœtuses would necessarily remain longer in the womb than those of larger and more robust bodies: which is by no means the case. Besides, it is not for nourishment that the child, immediately after birth, seems to be anxious; for it can want food for a considerable time after: it appears, on the contrary, to be extremely desirous of easing itself of the superfluous load of nourishment (the meconium) received in the womb. This circumstance induced Drelincourt, and some other anatomists, to think, that the acrimony and uneasiness, arising from an accumulation of excrement in the bowels, is the reason why they become restless, and use every effort to escape from the womb. I am not, I acknowledge, more satisfied with this explication than the others. If the child is pressed with fæces, why does it not evacuate them in the liquor amnii? But this never happens. It appears, on the contrary, that the necessity of evacuating the meconium is not felt till after birth, when the motion

of the diaphragm, occasioned by respiration, compresses the intestines, and gives rise to this evacuation; especially since no meconium was found in the amnios of a fœtus of ten months, who had not respired, and since an infant of six or seven months discharges the meconium soon after respiration.

Other anatomists, and particularly Fabricius ab Aquapendente, imagined that the fœtus left the uterus from a desire of being refreshed by respiration. But this cause seems to be as chimerical as any that has been mentioned. It is impossible that a fœtus can have any idea of respiration; and far less can it have any conception whether respiration would be agreeable or disagreeable.

After considering all these hypotheses, I suspect that the delivery of the fœtus depends on a cause of a very different nature. The menstrual flux returns at stated intervals. Though its appearance be interrupted by impregnation, its cause is not destroyed; and, though no blood is exhibited at the accustomed period, yet a revolution in the system, similar to what happens before impregnation, must take place. It is for this reason, that, in some women, the menses are not entirely suppressed during the first two or three months after conception. I imagine, therefore, that this periodic revolution happens as regularly after a woman has conceived as before, but that the blood is prevented from flowing, because the excretories of the uterus are swelled and shut up, unless when it arrives in such large quanti-

ties, and acts with such force, as to overcome the resistance with which it is opposed. In this case, a great quantity of blood rushes out, and an abortion is the consequence. But it frequently happens that a small quantity of blood appears, without producing this effect; because the blood has only been able to open a few of the canals or excretories of the uterus, while the rest remain entirely obstructed.

Though no blood appears, which is generally the case, the first revolution fails not to be accompanied with the same painful symptoms. During the first suppression of the menses, therefore, the uterus is affected with a considerable agitation, which, when a little augmented, entirely destroys the product of generation. Hence we may reasonably conclude, that few of those conceptions, which happen a short time before the accustomed return of the menses, are successful; because the action of the menstrual blood easily destroys the feeble roots of a germ so tender and so delicate. Those conceptions, on the contrary, which take place immediately after this periodic discharge, succeed much better; because the fœtus is allowed more time to grow, and to fortify itself against the action of the blood, when the next revolution happens in the system.

After the fœtus has been enabled to resist the action of the first revolution, the increase of its growth, and of its attachment to the uterus, render it still more capable of resisting any of the subsequent revolutions; abortions, indeed, some-

times happen during every revolution; but they are more rare in the middle of the period of gestation than either at the beginning or near the end. Why they are more frequent at the beginning, has already been explained: it only remains to show why they are likewise more frequent towards the end.

The fœtus generally comes into the world during the tenth month of the menses. When it is born at the ninth or eighth, it lives, and is not, therefore, regarded as an abortion. Some have pretended to have seen instances of children born at the seventh, and even at the sixth revolution, who, notwithstanding this unfavourable circumstance, continued to live. There is no difference between abortion and birth, but what relates to the living powers of the child. In general, the number of abortions in the first, second, and third months, for the reasons already assigned, is very great; and the number of premature births, in the seventh and eighth months, is also very great, in proportion to the abortions in the fourth, fifth, and sixth months; because, during this middle term of gestation, the product of generation having acquired strength and solidity sufficient to resist the action of the first four periodic revolutions, a more violent effort than any of the former is necessary to destroy the fœtus. For the same reason, an abortion is more difficult during the fifth and sixth months. But the fœtus, which till now was weak, and could exert its own force only in a feeble man-

ner, begins to move with more vigour; and, when the eighth revolution takes place, the efforts of the fœtus uniting with those of the uterus, and facilitating its exclusion, the fœtus may come into the world in the seventh month, and be in a capacity of living, whenever it happens to be unusually strong at this period. But, if the fœtus be excluded solely from a weakness of the uterus, which renders it unable to resist the action of the blood during the eighth revolution, the birth of it is considered as an abortion, and the child dies. But such cases are uncommon; for, if the fœtus has resisted the first seven revolutions, nothing but particular accidents can prevent it from resisting the eighth, unless it has acquired more vigour than is common at this period. A fœtus which has acquired the same degree of strength, but at a later period, will be excluded at the ninth revolution; and those which require nine months in obtaining this degree of strength, will be born at the tenth revolution, which is the most usual term. But, when the fœtus acquires not this degree of strength and perfection in nine months, it will remain in the uterus till the eleventh, or even the twelfth revolution, that is, till the tenth or eleventh month: of such late births many examples are recorded.

Other reasons, to confirm the opinion that the menstrual flux is the occasional cause of births at different periods, may be produced. The females of all animals which have no men-

ses bring forth very nearly at the same terms: the difference in the times of gestation is extremely small. We may, therefore, conclude, that this variation, which is very great in women, proceeds from the action of the menstrual blood, which is exerted at every periodic revolution.

We have already remarked, that the placenta adheres to the uterus by the papillæ only; that there is no blood either in these papillæ or in the lacunæ in which they are inserted; and that when they are separated, an operation which requires no great effort, a milky liquor only issues from them. Why, therefore, is the birth of a child uniformly followed by a considerable hæmorrhage, first of pure blood, and afterwards of blood mixed with a watery fluid? This blood proceeds not from the separation of the placenta; for the papillæ are drawn out of the lacunæ without any effusion of blood. Delivery, therefore, which is nothing more than this separation, ought to produce no hæmorrhage. Is it not more natural, on the contrary, to think that the action of the blood is the cause of the birth; and that it is this menstrual blood alone which forces the vessels of the empty uterus, and begins to flow immediately after delivery, in the same manner as it did before conception?

We know, that, for some time after conception, the sac which contains the product of generation, adheres not to the uterus. We have seen, from the experiments of De Graaff, that, by

blowing upon the small globule, it changes its position. The adhesion to the uterus is never very strong: in the early periods of gestation, the placenta is slightly applied to the uterus; and these parts are only contiguous, or joined by a mucilaginous matter, which has hardly any adhesion. How, then, should it happen, that, in abortions of the first or second month, this globule never escapes without being attended with a great effusion of blood? This effusion cannot be occasioned by the passage of the globule, which has no adhesion to the uterus. It is by the action of the blood, on the contrary, that the globule is extruded. Should we not, therefore, conclude, that this is the menstrual blood, which, by forcing the canals through which it was accustomed to flow before impregnation, destroys the product of conception, and resumes its ordinary course?

The pains of child-bearing are principally occasioned by this action of the blood; for, it is well known, that they are equally violent in abortions of two or three months, as in ordinary births; and that many women feel, without having conceived very acute pains, whenever the menstrual flux is about to appear. These pains are of the same kind with those which accompany abortions or births. Ought we not, therefore, to ascribe them to the same cause?

It appears, then, that the periodic revolution of the menstrual blood has great influence in child-bearing, and that it is the cause why the

terms of delivery in women are more various than in other animals, which are not subject to this discharge, and which always bring forth at the same times. It is also apparent, that the revolution occasioned by the action of the menstrual blood is not the only cause of birth; the action of the fœtus itself contributes greatly to this end; for there are instances of children having made their escape from the uterus after the death of the mother, which could only happen from an exertion peculiar to the fœtus.

The terms of gestation in cows, sheep, and other animals, are always the same, and no hæmorrhage attends their delivery. May we not, therefore, conclude, that the blood discharged by women after delivery is the menstrual blood, and that the action of this blood upon the uterus, during every periodic revolution, is the reason why the human fœtus is excluded at so many different terms? It is natural to imagine, that, if the females of viviparous animals had menses like women, their deliveries would be followed by an effusion of blood, and be equally various in their terms. The fœtuses of animals are brought forth covered with their membranes: and it is seldom that the membranes are broken, or the waters flow before delivery. But the birth of a child, with its membranes entire, is a rare phænomenon. This circumstance seems to evince, that human fœtuses make greater efforts to escape from

their prison than those of other animals, or that the uterus of a woman affords not so free a passage to the child; for it is by the struggles of the fœtus against the resistance it meets with at the orifice of the uterus, that the membranes are torn.

RECAPITULATION.

ALL animals are nourished by vegetables, or by other animals which feed upon vegetables. There is, therefore, in Nature, a matter common to both, which serves for the growth and nourishment of every thing that lives or vegetates. This matter can have no other mode of effecting growth and nourishment, but by assimilating itsel[illegible] of the animal or vegetable, and [illegible]ely penetrating the texture and *fo*[illegible] parts, which I have distinguished b[illegible]llation of an *internal mould*. When this nutritive matter abounds more than is sufficient for the growth and expansion of the animal or vegetable, it is detached from all parts of the body, and deposited in one or several reservoirs, under the form of a fluid. This fluid contains all the particles which are analogous to the different parts of the body, and, of course, all that is necessary for the reproduction of a being in miniature perfectly similar to the first. In most animals, this superfluity of nutritive matter does not take place till they have nearly acquired their full growth; and hence it is that animals are not capable of generating before this period.

When this nutritive and prolific matter, which is universally diffused, has passed through the internal mould of an animal or vegetable, and has found a proper matrix, it produces an animal or vegetable of the same species. But when it finds not a suitable matrix, it produces organized beings different from animals or vegetables, as the moving and vegetating bodies which appear in the seminal fluids of animals, and in the infusions of the buds of plants, &c.

This prolific matter is composed of organic particles, which are always active, whose motions and actions are fixed or arrested by the brute parts of matter in general, and particularly by oily and saline [illegible]s: but as soon as they are disengaged [illegible]is matter, which is foreign to their nature [illegible]me their action, and produce different s[illegible]s of plants, and other animated beings.

The effects of this prolific matter may be seen by the microscope in the seminal fluids of both male and female animals. The semen of viviparous females is filtrated through the glandulous bodies which grow upon their testicles; and these glandulous bodies contain a considerable quantity of seminal fluid in their cavities. Oviparous females, as well as the viviparous, have a seminal fluid, which is still more active than that of the viviparous. The semen of the female is, in general, similar to that of the male, when both are in a natural state. They decompose in the same manner; they contain similar

organic particles; and they exhibit the very same appearances.

All animal and vegetable substances contain a great quantity of this organic and prolific matter. To discover it, we have only to separate it from the brute matter in which it is entangled; and this operation is effected by infusing animal or vegetable substances in water: the salts melt, the oils separate; and the organic particles become evident by their movements. They abound more in the seminal fluid than in any other parts of animals; or, rather, they are there more disengaged from the brute matter. Soon after flesh is infused, and, while it is only slightly dissolved, the organic matter appears under the form of moving bodies, which are nearly as large as those in the seminal fluid. But in proportion to the increase of the dissolution, the size of the organic particles is diminished, and their motion is augmented; and, when the flesh is entirely decomposed or corrupted, the organic particles are extremely minute, and their motion is inconceivably rapid. It is then that this matter may be poisonous, like that of the viper's tooth, in which Dr. Mead perceived an infinite number of small pointed bodies, and which he imagined to be salts, though they are nothing but the same organic particles in an extremely active state. The pus which proceeds from wounds may acquire such a degree of putrescency, as to become a poison of the most active kind; for, whenever this active

matter is exalted to a certain point, which may always be distinguished by the rapidity and minuteness of the moving bodies it contains, it must become a species of poison. The same thing may be remarked with regard to the poison of vegetables. The same matter which nourishes us while in a natural state, will destroy us when it is corrupted, as appears from the gangrenes which affect the limbs of men and other animals, when they are fed with corrupted grain; and from comparing the residue of the food which adheres to our teeth, with that which proceeds from the teeth of the viper or of a mad dog, which is nothing but the same matter too much exalted, and in the highest state of putrefaction.

When large quantities of this organic and prolific matter are collected in some part of an animal, where it is obliged to remain, it there forms living beings, which we have always regarded as real animals. The tænia, the ascarides, all the worms found in the veins, in the liver, in wounds, in pus, and most of those which are formed in putrified flesh, have no other origin. The eels in paste, in vinegar, and all the pretended microscopic animals, are only different forms assumed, according to circumstances, by this active matter, which has a perpetual tendency to organization.

In infusions of all animal and vegetable substances, this prolific matter first discovers itself under the form of vegetation: we see it form

into filaments, which grow and expand like plants; then their extremities and joints swell and burst to give passage to the multitude of moving bodies which have the semblance of animals. Nature, it would appear, begins all her operations by a kind of vegetable motion: this motion we perceive in a variety of microscopic objects, and in the expansion of the animal embryo; for a fœtus, at first, possesses only a species of vegetable growth or motion.

Sound food furnishes none of these moving particles for a considerable time: fresh meat, grain, fruits, &c., require some days' infusion before they exhibit any moving bodies. But the more any matter is corrupted, decomposed, or exalted, as pus, blighted grain, honey, the seminal fluids, &c., these moving bodies make their appearance the sooner. In seminal fluids, they are entirely free from other matter; and only a few hours' infusion is necessary to discover them in pus, corrupted grain, honey, strong drugs, &c.

The existence, therefore, of an organic animated matter, universally diffused through all animal and vegetable substances, and which equally serves for their nourishment, their growth, and their reproduction, is apparent. Nutrition is effected by the intimate penetration of this matter through every part of animal or vegetable bodies; expansion, or growth, is only a more extensive species of nutrition, which proceeds as long as the parts are ductile, and

capable of being stretched; and reproduction is an effect of the same matter, when it superabounds in the body of an animal or vegetable. Every part of organized bodies sends off to proper reservoirs the organic particles which are superfluous for its nourishment: these particles are perfectly similar to the different parts from which they are detached, because they were destined for the nourishment of those parts. Hence, when the whole particles sent off from every part of the body are assembled, they must necessarily form a small body similar to the original, because every particle is similar to the part from which it was detached. It is in this manner that every species of reproduction, where only one individual is requisite, as that of trees, plants, polypi, vine-fretters, &c., is effected. This is also the first method employed by nature for the reproduction of such animals as require the aid of different sexes; for the seminal fluid of each sex contains all the particles necessary for reproduction: but, to complete the operation, something more is requisite, namely, the mixture of both fluids in a place suited to the expansion and growth of the fœtus; and this place is the uterus of the female.

There are, therefore, no preexisting germs, or germs infinitely contained within each other. But there is an organic matter diffused through all animated nature, which is always active, always tending to form, to assimilate, and to produce, beings similar to those which receive it. The

species of animals and of vegetables, therefore, can never be exhausted: as long as individuals subsist, the different species will be constantly new; they are the same now that they were 3,000 years ago: the whole will perpetually exist by their own powers, unless they be annihilated by the will of their Creator.

THE TANJORE MAHARAJA SERFOJI'S SARASWATI MAHAL.

THE NATURAL HISTORY OF MAN.

SECT. I.

Of the Nature of Man.

THOUGH man be much interested in obtaining a knowledge of himself, yet I suspect that he is better acquainted with every other object. Endowed by Nature with organs destined solely for our own preservation, we employ them for the reception of external impressions only. Anxious to expand our external existence beyond the limits of our powers, and to multiply the functions of our senses, we seldom employ that internal sense which reduces us to our true dimensions, and distinguishes us from every other being. If, however, we are desirous of knowing ourselves, we must cultivate this sense, by which alone we are enabled to form a dispassionate judgment concerning our nature and condition. But how shall we give to this sense its full extent and activity? How shall we emancipate the

soul, in which it resides, from all the illusions of fancy? We have lost the habit of employing this sense; its activity is repressed by the tumult of corporeal sensations, and parched with the heat of our passions; the heart, the imagination, the senses, all conspire to annihilate its exertions. Unchangeable, however, in its nature, and invulnerable by its essence, it continues always the same. Its splendor may be obscured, without losing its force; it may enlighten us less, but it guides us with certainty. Let us collect those rays which it still emits, and the darkness which surrounds us will diminish; and though the path should not be equally illuminated from one end to the other, we shall at least have a torch to prevent us from wandering.

The first and most difficult step, in arriving at a proper knowledge of ourselves, is to acquire distinct ideas of the two substances of which we are composed. Simply to affirm, that the one is immaterial, unextended, and immortal, and that the other is material, extended, and mortal, is only denying those qualities to the one, which we know the other possesses. What real knowledge can be acquired from this mode of negation? Such negative expressions can communicate no positive idea. But, to say that we are certain of the existence of the former, and less assured of that of the latter; that the substance of the one is simple, indivisible, and has no form, because it manifests itself only by a single modification, which is that of thought; that the other is less a substance, than a subject capable of re-

ceiving species of forms relative to our senses, which are all as uncertain and as variable as the organs themselves, is advancing one step towards a distinct idea of the nature of the two substances: it is ascribing to both different and peculiar properties; it assigns to them positive qualities, and enables us to institute a comparison between them.

All our knowledge is ultimately derived from comparison. What is absolutely incomparable, must be incomprehensible. Of this God is the only example: he cannot be comprehended, because he can be compared with no other being. But every thing which is susceptible of being compared, and of being relatively viewed in different lights, becomes a source of human knowledge. The more subjects of comparison which any object affords, the means of forming a proper knowledge concerning it are proportionally increased and facilitated.

The existence of the soul is self-evident: to be, and to think, are, with regard to us, the same thing. This truth is more than intuitive: it is independent of the senses, of the imagination, of the memory, and of all our other relative faculties. But the existence of our bodies, and of external objects, is doubtful to every unprejudiced reasoner; for that extension in length, breadth, and thickness, which we call our bodies, and which seem to be so intimately connected with us, is nothing more than a relation of our senses; and the organs of sensation themselves are only certain affinities with the objects which

affect them. Has the internal sense, the mind, any thing common or similar to these organs? Have the sensations produced by light or sound any resemblance to that subtile fluid which excites the idea of light, or to the vibration of the air which conveys to us the notion of sound? These effects result solely from the necessary and intimate relation that subsists between the eyes and ears and the different matters which act upon them. But, as we have demonstrated, that there is no resemblance between sensations and the objects which produce them, is not this a sufficient proof that the nature of the soul is different from that of matter?

We may, therefore, consider it as an established point, that internal sensation is totally different from its cause; and we have already shown, that, if external objects exist, they must be very different from the ideas we form of them; because sensation has not the most distant resemblance to the objects by which it is excited. May we not hence conclude, that the causes of our sensations necessarily differ from our notions concerning them? That extension which we perceive by the eye, that impenetrability of which we acquire the idea by touching, and all the other constituent properties of matter, may have no existence; since our internal sensations of extension, impenetrability, &c., are neither extended nor impenetrable, and possess nothing in common with these qualities.

As the mind, during sleep, is affected with sensations which are often different from those

excited by the actual presence of the objects; is it not natural to think, that the presence of objects is not necessary to the existence of our sensations, and, consequently, that both mind and body may exist independent of these objects? For during sleep, and after death, the body has the same existence as before, though the mind recognises not its existence, and, with regard to us, the body entirely loses its being. Now I ask, if any object that can exist, and afterwards be no more, which affects us in a manner totally different from what it is, and from what it has been, can be so real as to leave no doubt of its existence?

We may still, however, believe, though we are uncertain, that something exists without us; but we cannot hesitate concerning the real existence of every thing within us. The existence of the soul, therefore, is certain, and that of the body seems to be doubtful. The mind has one mode of perception when we sleep, and another when we are awake; after death, she will perceive in a manner still more different; and the objects of sensation, or matter in general, may then have no more existence with regard to her, than our bodies, with which we have no farther connexion.

But, though we admit the existence of matter, and that it exists in the very manner we perceive it; yet, in comparing it with the mind, we shall find the latter endowed with qualities so opposite, that we cannot hesitate concerning the

difference of its nature, and the superiority of its rank.

It is impossible to recognise the mind under any other form than that of thinking, which is extremely general, simple, and uniform. This form is not divisible, extended, impenetrable, nor possesses any other quality of matter. The mind, therefore, which is the subject of this form, must be indivisible and immaterial. Our bodies, on the contrary, as well as all external objects, have many forms, each of which is compounded, divisible, and destructible; and the whole are only relative to the different organs by which we perceive them. Our bodies, and matter in general, therefore, possess no constant, real, or universal properties, which can enable us to acquire a certainty of their existence. A blind man has no idea of the images of bodies presented to us by means of light. A leper, whose skin was insensible, could have none of those ideas which originate from the sense of feeling. A deaf man knows nothing of sound. Supposing a person to be successively deprived of these three instruments of sensation, the mind would still exist, and manifest itself by its own internal power of thinking. But, if you abstract colour, extension, solidity, and all the other qualities of matter which have a relation to our senses, matter, in this case, would be entirely annihilated: the mind, therefore, is indestructible; but matter may, and must perish.

The same reasoning applies to the other fa-

culties of the mind, when compared with the most essential properties of matter. The mind wills and commands; the body obeys as far as it is able: the mind can unite itself, in an instant, to the most distant or most elevated objects; and nothing can prevent this union, when she commands it to be effected. But the body is incapable of uniting with any object; it is wounded by every thing that makes too close an approach. Every thing resists and becomes an obstacle to its motions, which are naturally slow. Is this will, then, nothing more than a corporeal movement; and is contemplation only a simple contact? How could this contact be effected with remote objects, or abstract subjects? Or how could this motion be instantaneously accomplished? Without space and time, the idea of motion is inconceivable. The will, therefore, if it be a motion, is not a material motion; and, if the union of the mind with its object be a contact, it must be a contact, or rather an intimate penetration, at a distance! qualities which are the reverse of those of matter, and which, of course, can belong only to an immaterial being.

But I am apprehensive of having dwelt too long upon a subject, which, by some, may be regarded as foreign to the nature of this work. What connexion, it may be said, have metaphysical remarks on the mind with natural history? If I were conscious of abilities sufficient for the discussion of a topic so elevated and extensive, this reflection, I acknowledge, would not give me

any uneasiness; and I have abridged my observations, solely because I despaired of being able to comprehend a subject so immense, and so important in its nature. Why should the noblest part of man be rejected from his history? Why thus preposterously debase him, by considering him merely as an animal, while his nature is so different, and so superior to that of the brutes, that nothing but the most brutal ignorance could ever dream of confounding them?

Man, it is true, resembles the other animals in the material part of his being; and, in the enumeration of natural existences, we are obliged to rank him in the class of animals. But, in nature, there are neither classes nor genera; all are mere independent individuals. Classes and genera are only the arbitrary operations of our own fancy: and, though we place man in one of these classes, we change not his nature; we derogate not from his dignity; we alter not his real condition; we only assign him the first rank among beings which resemble him solely in the material part of his existence.

When we compare man with the animal creation, we find in both a material organized body, senses, flesh and blood, motion, and many other striking resemblances. But all these analogies are external, and authorize us not to pronounce, that the nature of man is similar to that of the brute. In order to acquire a distinct idea concerning the nature of each, it is necessary that we should have as complete a knowledge of the internal qualities of animals as we have of our

own. But, as it is impossible to know what passes within animals, or how to rank or estimate their sensations, in relation to those of man, we can only judge by comparing the effects which result from the natural operations of both.

Let us, therefore, consider these effects; and, while we acknowledge all the particular resemblances, we shall only examine some of the most general distinctions. The most stupid man, it will be admitted, is able to manage the most alert and sagacious animal: he governs it, and makes it subservient to his purposes. This he effects not so much by strength or address, as by the superiority of his nature. He compels the animal to obey him, by his being possessed of reason, which enables him to project and to act in a systematic manner. The strongest and most sagacious animals have not the capacity of commanding the inferior tribes, or of reducing them to a state of servitude. The stronger, indeed, devour the weaker: but this action implies an urgent necessity only, and a voracious appetite, qualities very different from that which produces a train of actions all directed to one common design. If animals be endowed with this faculty, why do not some of them assume the reins of government over others, and force them to furnish their food, to watch over them, and to relieve them when sick or wounded? But, among animals, there is no mark of subordination, nor the least trace of any of them being able to recognise or feel a superiority in his nature above that of other species. We should, therefore,

conclude, that all animals are of the same nature, and that the nature of man is not only far superior, but likewise of a very different kind from that of the brute.

Man exhibits, by external signs, what passes within him. He communicates his sentiments by words; and this sign is universal. The savage and the civilized man have the same powers of utterance; both speak naturally, and are equally understood. It is not owing, as some have imagined, to a defect in their organs, that animals are denied the faculty of speech. The tongue of a monkey has been discovered by anatomists to be as perfect as that of a man*. The monkey, therefore, would speak if it could think. If the train of its thoughts were analogous to that of ours, it would speak the language of men; and supposing the order and manner of its thinking to be peculiar to the species, it would still speak a language intelligible to its neighbours. But apes have never been discovered conversing together. Instead, therefore, of thinking in a manner analogous to man, they seem not to have the smallest order or train in their thoughts. As they express nothing that exhibits combination or arrangement, it follows, either that they do not think, or that the limits of their thinking are extremely narrow.

As several species of animals are capable of being taught to pronounce words, and even to repeat sentences, this is an invincible proof that

* See M. Perault, History of Animals.

the want of speech among them is not owing to any defect in their organs. Many other brutes might, perhaps, be taught to articulate words *; but, to make them conceive the ideas which these words express, is beyond the power of art. They seem to articulate and to repeat merely like an echo or a machine. They are defective, not in the mechanism of their organs, but in their intellectual powers.

Language implies a train of thinking; and it is for this reason that brute animals are incapable of speech: for, though we should allow them to possess something similar to our first apprehensions, and to our most gross and mechanical sensations, it is certain that they are unable to form that association of ideas in which alone the essence of reflection and of thought consists. They can neither think nor speak, because they can neither join nor separate ideas; and, for the same reason, they neither invent nor bring any thing to perfection. If they were endowed with the power of reflecting, even in the slightest degree, they would be capable of making some progress, and acquire more industry; the present race of beavers would build their houses with more art and solidity than their progenitors; and the bee would daily improve the cell which she inhabits: for, by supposing that this cell has all the perfection of which it is capable, we ascribe to this insect a genius and understanding superior

* Leibnitz mentions a dog that had been taught to pronounce several French and German words.

to the human, by which it is enabled, at one glance, to perceive the utmost point of perfection to which its work can be carried. But man never can attain a clear view of this point: much time, reflection, and practice, are necessary, before the meanest of our arts can be brought to maturity.

Whence proceeds this uniformity in all the operations of animals? Why does every species perform the same work in the very same manner? And why is the execution of different individuals neither better nor worse than that of every other? Can there be a stronger proof that their operations are only the results of pure mechanical impulse? If they possessed a single spark of that inward light which illuminates mankind, we should find variety, at least, if not perfection, in their works; every individual would exhibit some difference in his mode of execution. But such differences never appear: they all work upon the same plan; their mode of acting runs through the whole species, and is not peculiar to any individual. If, therefore, we ascribe to animals a mind or soul, we must allow but one to every species, of which each individual has an equal share: this soul would, of course, be divisible, and, consequently, material, and very different from ours.

Why, on the contrary, is so much variety exhibited in the operations of men? Why does servile imitation cost us more labour than original design? Because our souls are proper to us, and independent of any other; and because we

possess nothing common to the species, but the matter which constitutes our bodies, and by which alone we have any resemblance to the brute creation.

If internal sensation depended on corporeal organs, should not as great a variety appear in the operations of the same species of animals, as in those of men? Would not those endowed with finer organs build their nests, and their cells, in a manner more solid, elegant, and commodious? If any individual had more genius than another, would it not be rendered conspicuous by its mode of acting? But nothing of this kind is ever exhibited; the greater or lesser perfection of corporeal organs, therefore, has no influence upon the nature of internal sensation. From this circumstance, we may safely conclude, that animals possess no sensations of this kind; that they neither belong to matter, nor depend, as to their nature, upon the texture of corporeal organs; and, of course, that there is in man a substance totally distinct from matter, which is the subject and the cause that produce these sensations.

But these proofs of the immateriality of the human mind may be extended still farther. We have often remarked, that Nature proceeds in her operations by imperceptible degrees. This truth, which otherwise admits of no exception, is here totally reversed. Between the faculties of man and those of the most minute animal, the distance is infinite. This is a clear proof, that the nature of man is different from that of

the brute creation; that he himself constitutes a separate class, from which there are numberless degrees of descent, before we arrive at the state of the mere animal; for, if man were of the same rank with the animals, there would be in Nature a certain number of beings less perfect than man, and superior to any animal we are acquainted with; and those intermediate beings would descend imperceptibly from man to the monkey tribes. But no such beings exist. The passage is sudden from a thinking being to a material one, from intellectual faculties to mechanical powers, from order and design to blind impulse, from reflection and choice to ungovernable appetite.

This is a strong indication of the excellence of our nature, and of the immense distance fixed by the bounty of the Creator between men and animals. Man is a reasoning being; the animal is totally deprived of that noble faculty: and as there is no intermediate point between a positive and a negative, between a rational and an irrational animal, it is evident that man's nature is entirely different from that of the animal; that the latter only resembles the former in the external or material part; and that, to form a judgment from this material resemblance alone, is shutting our eyes voluntarily against that light which enables us to distinguish truth from falsehood.

Having considered the internal nature of man, and demonstrated the immateriality of his soul, we shall next examine his external part, and give

the history of his body. In the preceding chapters, we have explained his formation and expansion, and traced him to the very moment of his birth: let us now run over the different ages of his life; and, after conducting him to that period when he is separated from his body, we shall leave it to moulder in the common mass of matter, to which it originally belonged.

SECT. II.

Of Infancy.

NOTHING exhibits such a striking picture of weakness, of pain, and of misery, as the condition of an infant immediately after birth. Incapable of employing its organs or its senses, the infant requires every kind of succour and assistance: it is more helpless than the young of any other animal: its uncertain life seems every moment to vibrate on the borders of death. It can neither move nor support its body: it has hardly force enough to exist, and to announce, by groans, the pain which it suffers; as if Nature intended to apprise the little innocent, that it is born to misery, and that it is to be ranked among human creatures only to partake of their infirmities and of their afflictions.

Let us not disdain to consider that state in which our existence commenced: let us view human nature in the cradle; and, leaving the disgust that might arise from a detail of the cares which infancy demands, let us inquire by what degrees this delicate and hardly existing machine acquires motion, consistency, and strength.

An infant, at birth, passes from one element into another. When it escapes from the waters which surrounded it in the womb of the mo-

ther, it is exposed to the air, and instantly feels the impressions of that active fluid. The air acts upon the olfactory nerves, and upon the organs of respiration. This action produces a shock, a kind of sneezing, which expands the chest, and gives the air a free passage into the lungs, the vesicles of which it dilates. After the air remains for some time, it is heated and rarefied to a certain degree, and the stimulus or spring arising from the dilatation of the fibres reacts upon this rarefied fluid, and expels it from the lungs. We will not here attempt to explain the causes of the alternate motion of respiration, but shall confine ourselves to its effects.

This function is essentially necessary to the existence of man and of many other animals. If respiration ceases, the animal must perish; when once commenced, it never stops till death; and, after the fœtus begins to respire, it continues this action without interruption. It is probable, however, that the foramen ovale of the heart does not close immediately after birth, and, consequently, that part of the blood must pass through that aperture. The whole blood, therefore, enters not, at first, into the lungs; and a new-born child may perhaps be deprived of air for a considerable time without suffocation. This conjecture seems to be confirmed by some experiments I lately made upon young dogs. I procured a pregnant bitch, of the large grayhound kind, and, when just about to litter, I fixed her so in a bucket full of warm water, that her hin-

der parts were entirely covered. In this situation she brought forth three puppies, which, after being disengaged from their membranes, were immersed in a fluid nearly of an equal temperature with that of the amnios. After assisting the mother, and washing the puppies in this water, I suddenly removed them into a pail of warm milk, without allowing them time to respire. I put them into the milk, in preference to water, that they might have an opportunity of taking some food, if they found a desire for nourishment. I kept them immersed in the milk for more than half an hour; and, when taken out of it, all the three were alive. They began to breathe; and they discharged a quantity of fluid matter by the mouth. I allowed them to respire about half an hour, and again immersed them in the warm milk, where they remained another half hour. I then took them out: two of them were still vigorous; but the third seemed to languish: I therefore ordered it to be carried to the mother, which, beside the three brought forth in the water, had littered other six in the natural manner. The puppy which was born in the water, and had continued one half hour in warm milk, before it was allowed to breathe, and another half hour after it had respired, seemed to be very little incommoded; for it soon recovered, and was as active and lively as those which had received no injury. Of the six that were brought forth in the air, I threw away four; so that there remained only two with the mother, beside the one that had been

littered in the water. I continued my experiments upon the other two, which had been twice immersed in the milk: after allowing them to breathe about half an hour, I plunged them a third time into the milk, where they remained another half hour. Whether they swallowed any of the milk, I could not determine; but, when removed, they appeared to be nearly as vigorous as before their immersion. Having carried them to the mother, however, one of them died that same day: but I know not whether its death was owing to some accident, or to the injury it received from being plunged into the milk, and deprived of air. The other lived as well as the first; and both grew up, and were equally vigorous as those which had not been subjected to the experiment. I pushed these trials no farther: but I learned enough to convince me, that respiration is not so indispensibly necessary to the existence of a new-born animal, as to an adult; and that, by employing certain precautions, it is, perhaps, possible to keep the foramen ovale open, and, by this means, produce excellent divers, or a species of amphibious animals, which would be able to live equally in air or in water.

The air, on its first entrance into the lungs, generally meets with some obstacle, occasioned by the fluid substance collected in the windpipe. This obstacle is greater or less in proportion to the viscidness of the liquor. But the infant, at birth, raises its head, which formerly reclined on its breast; and, by this operation, the canal of

the windpipe is lengthened; the air, of course, rushes in, forces this fluid into the cells of the lungs, which it dilates; and, in this manner, the mucous substance, which opposed the free passage of the air, is diffused through the whole substance of the lungs. The perpetual admission of fresh air soon dries up this superfluous moisture; or, if it should still incommode the infant, it excites a cough, and is thrown off by expectoration, which generally runs out of the mouth, because the child has not yet strength enough to spit.

We can remember nothing that passes at this early period of our existence. It is, therefore, impossible to discover the feelings produced in the child by the first impressions of the air. But the cries it utters immediately after birth, are certain indications of the pain occasioned by the action of the atmosphere. Till the moment of birth, the infant is accustomed to the mild warmth of a tranquil fluid. It is, therefore, consonant to reason, that the action of a fluid unequal in its temperature, is too violent for the lax and delicate fibres of a new-born infant. It is equally sensible of heat as of cold: in every situation it utters complaints; and pain appears to be its first and only sensation.

Most animals are blind for some days after birth. Infants open their eyes the moment they come into the world; but their eyes are fixed and dull: they have not that lustre and brilliancy they afterwards acquire; neither have they those motions which accompany distinct vision.

But they seem to feel the impression of light; for the pupil contracts or dilates, in proportion to the quantity of light. A new-born infant cannot distinguish objects; because the organs of vision are still imperfect: the cornea is wrinkled; and perhaps the retina is too soft and lax for receiving the impressions of external bodies, and for producing the sensations peculiar to distinct vision.

The same remark may be applied to the other senses. They have not yet acquired that force and consistency which the operation of the senses demand: and, even when they arrive at this state, it is long before the sensations of the infant can be just and complete. The senses are instruments of which we must gradually learn the use. That of vision is the most noble, and the most wonderful; but, at the same time, it is the most uncertain and elusory. The sensations produced by it, if not rectified every moment by the sense of touching, would uniformly lead us into false conclusions. The sense of touching is the criterion of all the other senses: it alone is essential to animal existence, and is universally diffused through every part of the body. But even this sense is imperfect at birth: a new-born infant, indeed, discovers symptoms of pain by its cries; but it has no expression that indicates pleasure. It begins not to smile in less than forty days: it is about this time, likewise, that it begins to weep; for its former cries were not accompanied with tears. There are no vestiges of the passions in the coun-

tenance of a new-born child. The features of the face have not acquired that consistence and elasticity which are necessary for expressing the sentiments of the mind. All the other parts of the infant's body are extremely feeble; and their motions are awkward and ill directed. It is unable to stand erect; its thighs and legs are still bended, from the habit contracted while in the womb of the mother; it has not strength to stretch out its arms, or to lay hold of any thing with its hands; and, if abandoned in this condition, it would remain on its back, without being able to turn to one side or another.

From these remarks, it appears, that the pain felt by infants recently born, and which they express by crying, is only a corporeal sensation, similar to that of other animals, who likewise cry the moment they are brought forth; and that mental sensation commences not sooner than forty days after birth; for smiles and tears are the effects of two internal sensations, which both depend upon the action of the mind. The former is an agreeable sensation, which originates from the sight or remembrance of a known and desirable object. The latter is a disagreeable agitation, compounded of sympathy and anxiety concerning our own welfare. Both these passions presuppose a certain degree of knowledge, and a power of reflecting, and of comparing ideas. Smiles and tears are expressions of pleasure and pain peculiar to the human species; for the cries, the motions, and the other marks of bodily pains and pleasures,

are common to man and most of the other animals.

But we must now return to the material organs and affections of the body. The size of an infant born at the full time is generally about twenty-one inches, though some exceed, and others fall much below this standard. The breast of a child of twenty-one inches, measured by the length of the sternum, is about three inches, and only two, when the infant exceeds not fourteen inches in length. At nine months, a fœtus generally weighs from twelve to fourteen pounds. The head is large in proportion to the body; but this disproportion gradually wears off, as the infant increases in size. The skin of a new-born child is very fine, and of a reddish colour, its transparency allowing a slight tint of the blood to shine through. It is even alleged, that the redder the skin of an infant is at birth, it will afterwards become the fairer and more beautiful.

The form of the body and members of infants, recently after birth, is by no means perfect. The parts are too much rounded; and, even when the child is in high health, they have a swollen appearance. A kind of jaundice generally comes on at the end of three days; and at the same time there is milk in the breasts of infants, which is squeezed out by the fingers. As the growth of the child increases, the superfluous juices and swelling of the parts gradually diminish.

In some infants, a palpitation may be seen in

the fontanella, or opening of the head; and, in every child, the beating of the sinuses, or arteries of the brain, may be felt at this place. Above this opening a species of scurf appears, which is often very thick, and must be rubbed off with a brush, when it becomes dry. This matter seems to have some analogy to the horns of quadrupeds, which likewise derive their origin from an opening in the skull, and from the substance of the brain. We shall afterwards show, that the extremities of the nerves become solid when exposed to the air; and that horns, nails, claws, &c., are genuine productions of this nervous substance.

The fluid contained in the amnios leaves upon the infant's body a viscid whitish matter, which is sometimes so adhesive, that it requires to be diluted with some mild liquid before it can be removed. In this country, we always wash the infant with warm liquors; but there are whole nations, who inhabit climates much colder than ours, where the infants are plunged into cold water as soon as they are born, without receiving the smallest injury. The Laplanders are even said to leave their new-born infants in the snow till their respiration is almost stopped with cold, and then throw them into a warm bath. This rough treatment is continued three times every day for the first year; and, after that period, the children are bathed thrice a week in cold water. The inhabitants of the northern regions are firmly persuaded that cold bathing makes men more healthy and robust; and, therefore, they inure

their children to this habit from their very birth. We are, indeed, totally ignorant how far our bodies may be rendered capable of suffering, of acquiring, or of losing by the power of habit. The savages in the isthmus of America, when covered with sweat, plunge themselves into cold water with impunity: the women throw their drunk husbands into the rivers, in order the more speedily to remove the effects of intoxication: the mothers bathe in cold water along with their infants the moment after they are delivered; and yet much fewer of them die of child-bearing than in other countries, where a practice of this kind would be regarded as extremely dangerous.

Infants, a few minutes after birth, and generally after feeling the heat of a fire, discharge urine, and likewise the meconium or excrement which had been formed in the intestines during their abode in the womb. But this last evacuation does not always happen so soon; and, when it is retarded during the first day, the child is often affected with cholic pains; the discharge must, therefore, be promoted by proper remedies. The meconium is black, and, when entirely purged off, the stools are of a whitish colour. This change generally happens on the second or third day. The odour of the excrement becomes then more offensive than that of the meconium; which is a proof that the bile, and other bitter humours of the body begin to be mixed with the fæces.

This observation seems to confirm what was formerly advanced concerning the growth and

nourishment of the fœtus. We then remarked, that the fœtus was nourished by absorption, and that it received no food by the mouth. This change in the odour of the excrement is a proof that the stomach and intestines of the fœtus have no action, or, at least, that they act not in the same manner, as after the motions communicated to them by respiration; since it is only after this period that digestion, and the mixture of the bile and pancreatic juice with the food, takes place in the stomach and intestines. Thus, though the bile and pancreatic juice are secreted in the fœtus, these liquors remain in their reservoirs, and pass not into the intestines; because, like the stomach, these reservoirs have yet no motion or action sufficient to make them empty their contents into the receptacles of the food.

Before the child is allowed to suck, we allow it time to discharge the slime and meconium in its stomach and bowels. As these substances might sour the milk, and produce bad effects, we first give the child a little wine and sugar, in order to fortify its stomach, and to promote such evacuations as are necessary to prepare it for receiving and digesting its food. Ten or twelve hours, therefore, ought to elapse, before the child be allowed to suck for the first time.

The infant has hardly escaped from the womb of its mother, and enjoyed the liberty of stretching its limbs, when it is again condemned to a more cruel and unnatural bondage. The head of the little innocent is fixed; its legs are fettered; its arms are bound down to its sides; and it is laced

with bandages so strait, that it cannot move a single joint. It is a fortunate circumstance, when the swaddlings are not drawn so tight as to stop respiration, or when the midwife has the sense to lay the miserable captive on its side, that the natural moisture may spontaneously flow from its mouth; for it is denied the liberty of turning its head to facilitate this necessary discharge. Is it not an instance of superior wisdom in those nations, who simply clothe their infants, without tormenting them with swaddling bands? The Siamese, the Indians, the Japanese, the Negroes, the Savages of Canada, of Virginia, of Brasil, and almost all the inhabitants of South America, lay their infants naked into hanging beds of cotton, or put them into cradles lined with fur. These practices are both sensible and humane: the restraint of swaddling bands must be painful. The efforts made by infants to disentangle themselves have a more direct tendency to distort their members, than any positions they could assume, if left in the full possession of liberty. Swaddling bands may be compared to the stays worn by young girls, which occasion many more deformities and diseases than they are intended to prevent.

If the efforts for liberty made by infants thus fettered be hurtful, the inactivity to which they are condemned is, perhaps, still more noxious. The want of exercise retards the growth of their members, and diminishes the strength of their bodies; and, of course, those children who are

allowed full freedom of motion will be the most vigorous and healthy. It was this motive that induced the Peruvians to leave the arms of their infants perfectly loose, in a wide swathing bag: afterwards, when their children grew older, they put them up to the middle in a hole dug out of the earth, and lined with linen; their arms, by this contrivance, were at full liberty; and they could move their heads, and bend their bodies, without falling, or hurting themselves. As soon as they were able to step, the breast was presented to them at a little distance, to entice them to walk. The children of negroes are often exposed to greater difficulties before they can approach the nipple; they cling round one of the mother's haunches with their knees and legs; they adhere so fast, that they support themselves without the assistance of the mother; they lay hold of the breast with their hands; and they continue to suck without inconvenience or danger of falling, though the mother moves about or works at her ordinary labour. These children begin to walk, or rather to creep, on their hands and knees, at the end of the second month; and, by exercise, they acquire the faculty of running, in this situation, with nearly equal quickness as they do upon their feet.

Infants, recently after birth, sleep much; but their sleep is often interrupted. As they likewise require frequent nourishment, they ought to have the breast once every two hours during the day, and, in the night, as often as they awake. At

first, they sleep almost continually; and they seem never to awake but when stimulated by hunger or pain: their sleep, therefore, generally terminates by a fit of crying. As, in the cradle, they are obliged to lie in the same position, and are chained down by bandages, this situation soon becomes painful. They are, besides, often wet and chilled by their excrements, the acrimony of which irritates their delicate and sensible skin. In this condition, the efforts of children are extremely feeble; and their calls for relief are expressed by cries and groans. This succour should always be speedily administered; or rather the inconveniences they feel should be prevented, by frequently changing part of their clothing. The savages are so attentive to this article, that, though they cannot change their furs so often as we do our linen cloths, yet they supply the defect by employing other substances, of which they have no occasion to be sparing. In North America, they put wood dust, which they obtain from trees that have been corroded by worms, into the bottom of the cradle, and renew it as often as necessary; the children are laid upon this powder, and covered with skins. Though this powder, may, perhaps, be as soft as our down beds; yet they use it not for the purposes of delicacy, but because it quickly absorbs moisture of every kind. In Virginia, they place the child naked upon a board covered with cotton, and provided with a hole for the passage of the excrement. The cold in this country is unfavourable to such a practice; but it is almost general in the east of Europe, and

particularly in Turkey. This precaution has another advantage; it precludes all kind of care, and prevents the dreadful effects which too commonly result from the common negligence of nurses. Nothing inferior to maternal affection can support that perpetual vigilance and minute attention which the infantine state requires. With what propriety, then, can such exertions be expected from ignorant and mercenary nurses?

Some nurses desert their children for several hours without feeling the smallest anxiety: others are so callous as not to be affected by their cries. In this situation the unfortunate infant seems to despair; they exert all the force of which they are capable; and their cries only cease when their strength is exhausted. This excessive crying either occasions diseases, or at least throws them into a state of lassitude, which deranges their constitutions, and may have some influence on their tempers. Indolent nurses are guilty of another abuse: instead of employing proper means for pleasing the child, they rock it violently in the cradle. This agitation confuses the brain, stops the crying, and, if long continued, stuns the child into sleep. But this forced and unnatural sleep is only a palliative; it removes not the original cause of complaint. Long and violent rocking, on the contrary, may disorder the stomach and head, and lay the foundation of future disorders.

Before children are put into the cradle, we ought to be certain that they want nothing; and they should never be rocked with such violence

as to confound or stun them. If they sleep not sufficiently, a gentle and equal motion may be employed. Neither should they be often rocked; for, if they be once accustomed to this motion, they will not afterwards sleep without it. Though children, when in health, should sleep long without the assistance of art; yet their constitution may be injured by too much sleep. In this case, they should be roused by gentle motion, by soft and agreeable sounds, and by amusing them with brilliant objects. This is the period when they receive the first impressions from the senses, which are, perhaps, of more importance during life than is generally imagined.

Infants always direct their eyes to the lightest part of a room; and if, from the child's situation, one eye only can see the most luminous part, the other, for want of equal exercise, will not acquire equal strength. To prevent this inconvenience, the foot of the cradle, whether the light proceeds from a window or a candle, should be placed opposite to the light: in this position both eyes receive the light at the same time, and consequently acquire, by exercise, an equal degree of strength: if one eye acquires more strength than the other, the child will squint; for I have elsewhere proved, that an inequality of strength in the eyes is the cause of squinting *.

For the first two months, the infant should receive no other food than the milk of the mother or nurse; and, if its constitution be deli-

* See Mem. de l'Acad. des Sciences, ann. 1743.

cate, this nourishment alone should be continued during the third and fourth month. A child, however robust, may be injured, if any other food be administered before the end of the first month. In Holland, in Italy, in Turkey, and through the whole Levant, children are allowed no other food during the first year. The savages of Canada nurse their children four or five, and sometimes six or seven years. In our country, as most nurses have not a sufficient quantity of milk to satisfy the desires of their children, in order to spare it, they give them, even from the beginning, a composition of boiled bread and milk. This nourishment appeases hunger; but, as the stomach and intestines are yet too weak to digest such a gross, viscid substance, the children are greatly hurt by it, and often die of indigestion.

The milk of animals, in cases of necessity, may supply that of the mother: but then the child should be obliged to suck the animal's teat, that it may receive the milk in an equal and proper degree of heat, and that, by the action of the muscles in sucking, the milk may be mixed with saliva, which greatly promotes digestion. I have known several peasants who had no other nurses than ewes; and yet they were equally vigorous as those who had been nursed by their mothers.

After two or three months, when the child has acquired some strength, it may have food somewhat more solid, as flour baked with milk, a species of bread which gradually disposes the sto-

mach to receive common bread, and such other nourishment as it must afterwards be accustomed to take.

The consistence of liquid food is thus gradually increased, that the child's stomach may be prepared to receive what is still more solid. Infants, during the first year, are incapable of mastication. The rudiments of the teeth are still covered with the gums, which are so soft, that they can have little effect upon hard substances. Some nurses, especially among the common people, first chew the food, and then give it to their children. Before reflecting on this practice, we must throw aside every idea of disgust, of which children, at this age, have not the least conception. They are equally disposed to receive nourishment from the mouth of the nurse, as from her breasts. This custom seems to have originated from some natural instinct; for we meet with it in many countries which are exceedingly remote from each other; as in Italy, in Turkey, in most parts of Asia, in America, in the Antilles, in Canada, &c. As it is the only way by which the stomachs of children can be supplied with a proper quantity of saliva, I believe it is very useful to them. If the nurse chews a bit of bread, it is soaked in her saliva, which renders it fitter for nourishment than if it had been diluted in any other liquor. This practice, however, is unnecessary after children are furnished with teeth, which enable them to chew their food, and to mix it with their own saliva.

The *incisores*, or cutting-teeth, are eight in

number, four in each jaw, and they generally appear about the seventh month, though, in some cases, not till the end of the first year. These teeth are often premature; for some children have them at the birth, and fœtuses have been found with teeth completely formed long before the ordinary time of gestation is finished.

The rudiments of the teeth are lodged in sockets, and covered with the gums: in the process of their growth, they extend their roots to the bottom of the socket, and break through the gums. This process observes not the ordinary laws of Nature, which act continually on the human body, without occasioning any painful sensation. Here Nature makes a violent and painful effort, which is often attended with fatal consequences. Children, when teething, lose their usual sprightliness, and become peevish and fretful. The gums are at first red and swelled; and, when the circulation of the blood is nearly stopped by the pressure of the teeth, they turn whitish. Children perpetually apply their fingers to the affected part, in order to remove the irritation: to procure still farther relief, they are furnished with a piece of ivory, coral, or any other hard, smooth substance, which they rub against the gums. This operation relaxes the parts, affords a momentary cessation of pain, renders the gums thinner, and facilitates their rupture. But, notwithstanding every precaution, the rupture of the gums is always accompanied with pain and danger. When the gums are uncommonly strong and rigid, they resist the pres-

sure of the teeth for a considerable time, and occasion a violent inflammation, which often proves fatal. The simple operation of cutting the gum removes the inflammation, and gives a free passage to the teeth.

The canine or dog-teeth, which are four in number, and situated next to the cutting-teeth, generally appear in the ninth or tenth month. About the end of the first, or during the course of the second year, the sixteen molares or grinders, four on each side of the canine-teeth, cut the gums. But these periods vary greatly in diffrent children.

The cutting-teeth, the dog-teeth, and the first four grinders, are generally shed during the fifth, sixth, or seventh year; and are commonly replaced in the seventh year, though sometimes not before the age of puberty. The shedding of these sixteen teeth is occasioned by the expansion of the rudiments of a second set, which are situated at the bottom of the sockets, and, by their growth, push out the first set. But there is no second set below the other grinders; and therefore they never shed but by accident, and their loss is seldom repaired.

There are still other four teeth situated at the extremity of each jaw. In some persons, these teeth are entirely wanting: they seldom appear before the age of puberty, and sometimes not till a more advanced period. They are distinguished by the name of *wisdom-teeth*, and either appear successively, or two at a time. It is owing to this irregularity in the wisdom-teeth, that

the number of teeth is not uniformly the same, which varies from twenty-eight to thirty-two. Women, it has been alleged, have generally fewer teeth than men.

Some authors maintain, that the human teeth, like those of certain animals, would continue to grow during life, if they were not constantly worn down by grinding the food. But this notion seems to be contradicted by experience; for people who live upon liquid food have not longer teeth than those who eat the hardest kinds of aliment. Besides, those who hold this opinion probably mistake the tusks of certain animals for their teeth. The tusks of the wild boar, and of the elephant, for example, continue to grow during life; but their increase, after they arrive at their natural size, is extremely doubtful. Tusks have a greater analogy to horns than to teeth: but this is not a proper place for such discussions. We shall only remark, that, in children, the first set of teeth are less solid, and more loosely fixed in their sockets, than the second.

It has been often asserted, that the first hair of children is always brown; and that, after it falls off, it is replaced by hair of different colours. I am unable to determine whether this remark be well founded; but the hair of most children is fair, and often entirely white. In some it is red, and in others black: but in all those who are to have fair or brown complexions, the hair is more or less fair in early infancy. Those who are to be fair have generally blue

eyes; those who are to be red have yellowish eyes; and those who are to be brown have eyes of a dark yellowish colour: but these distinctions are imperfectly marked in children recently after birth; because their eyes are then almost always blue.

When infants are allowed to cry long and violently, ruptures are frequently the consequence of the efforts they make. These are easily reduced by the application of bandages. But, if this remedy be too long neglected, the disease may continue during life. The limits to which I have prescribed myself, permit me not to mention all the diseases incident to children. I shall only remark, on this subject, that worms, with which they are often infested, are produced from the nature of their food. Milk is a species of chyle, a purely nutritive substance, without any mixture: it, of course, consists entirely of organic and prolific matter, which, when not properly digested by the stomach, and applied to the nourishment and growth of the body, assumes, by its natural activity, other forms, and produces animated beings, or worms, in such profusion, that the child is often in danger of being destroyed by them. The bad effects occasioned by worms might perhaps be prevented, by allowing children to drink a little wine; because fermented liquors have a tendency to prevent the generation of worms: fermented liquors likewise contain few organic nutritive particles; and it is chiefly by acting on the

solids, that wine communicates strength to the body; for it contains little nourishment. Besides, most children are fond of wine; or, at least, they are easily accustomed to drink it.

Though the bodies of infants be extremely delicate, they are less sensible of cold than at any other period of life. Their internal heat, it would appear, is proportionally greater: the quickness of the pulse in children seems to fortify this opinion. Small animals, for the same reason, have unquestionably more heat than large ones; for the action of the heart and arteries increases in proportion to the comparative smallness of animals, which takes place in the same, as well as in different species. The pulse of an infant, or of a little man, is more frequent than that of an adult, or of a large man. The pulse of an ox is slower than that of a man; a dog's pulse is quicker than a man's; and the motion of the heart in very small animals, as that of a sparrow, is so rapid, that the strokes can hardly be numbered.

The life of a child, till it be three years of age, is extremely precarious. In the two or three succeeding years, however, its life becomes more certain; and, in the sixth or seventh year, a child has a better chance of living than at any other period. By consulting Simpson's Tables of the Degrees of Mortality at different Ages *, it appears, that, of a certain number of children,

* See Simpson's tables, published at London in 1742.

born at the same time, more than a fourth of them died in the first year, more than a third in two years, and at least one half in the first three years. If this calculation be just, when a child is born, we might lay a bet, that it would not live above three years. This exhibits a melancholy view of the human species; for, though a man who dies at the age of twenty-one is generally lamented, as being prematurely deprived of life; yet, according to these tables, one half of mankind must die before the termination of three years; and, consequently, every man who lives more than three years, instead of complaining of his fate, ought to consider himself as peculiarly favoured by his Creator. But this mortality of children is not nearly so great in every place as in London: M. Dupré de S. Maur has demonstrated, by a number of experiments made in France, that one half of the children born at the same time are not extinct in less than seven or eight years; and, therefore, we might insure the life of a new-born child for seven or eight years. When a child arrives at five, six, or seven years, it appears, from the same experiments, that its life is more certain than at any other age; for we may then insure for forty-two years more. But in proportion as it advances above five, six, or seven years, the number of years it will probably live constantly decreases. At twelve, for instance, the chance is equal for thirty-nine years only, at twenty for thirty-three and a half, at thirty for twenty-eight, and so on,

till the age of eighty-five, when the chance is equal for three years more *.

In the growth of the human body, one thing is exceedingly remarkable. The growth of the fœtus increases more and more, in equal times, till it escapes from the womb. The growth of the child, on the contrary, gradually diminishes, in equal times, till the age of puberty, to which it makes a sudden bound, and soon acquires its full stature. The fœtus, at the end of the first month, is an inch long; at the end of the second, it is two inches and a quarter; in three months, it is three inches and a quarter; in four months, it is more than five inches; in five months, it is six and a half, or seven inches; in six months, it is eight and a half, or nine inches; in seven months, it is more than eleven inches; in eight months, it is fourteen inches; and in nine months, it is eighteen inches. Though these measures vary in different subjects, yet the uniform result is, that the fœtus, in equal times, continues to have a proportionally greater increase. But if a child at birth be eighteen inches long, it will not acquire, for the next twelve months, above six or seven inches more; that is, at the end of the first year, it will be twenty-four or twenty-five inches; in two years, it will only be twenty-eight or twenty-nine inches; in three years it will be no more than

* See the Tables of the Probability of Life, at the end of sect. v.

thirty, or, at most, thirty-two inches; and afterwards, till the age of puberty, it will not acquire above one and a half, or two inches, every year. Thus the fœtus grows more in one month, when near the termination of its abode in the uterus, than the child does in one year, till it arrives at the age of puberty, when Nature seems to make a sudden effort to bring her work to maturity.

For preserving the health of children, virtuous and wholesome nurses are of the utmost importance. We have too many melancholy examples of certain diseases being communicated from the nurse to the child, and from the child to the nurse. Whole villages have, in this manner, been infected with the venereal virus.

Children, it is probable, would be much more strong and vigorous, if they were nursed by their mothers, whose milk must be more agreeable to them than that of any other woman; for the fœtus is nourished in the womb with a liquor which has a great resemblance to the milk in the breasts. Thus the infant is, in some measure, accustomed to the milk of the mother, even before its birth. But the milk of another woman is not only new to the child, but is often of so different a nature, that it is difficult to reconcile the child to the use of a stranger's milk. We sometimes see children, who cannot digest the milk of certain women, languish and turn diseased; and, if they are not speedily supplied with another nurse, they soon perish.

Nothing can be more destructive to children than the practice of crowding numbers of them

into the same hospital. Most of them die of infectious diseases, which they would certainly escape, if they were brought up in separate houses, and particularly at a distance from great towns. The same expense would be sufficient to support them; and numberle[illegible]ns, which constitute the riches of a state, would, by this simple and natural mode of treatment, be saved to the public.

Children begin the difficult task of learning to speak about the twelfth or fifteenth month. They pronounce the vowel A with more facility, because it requires only the opening of the mouth, and forcing out the air. E requires the tongue to be raised, at the same time that the lips are opened. In pronouncing I, the tongue is still more elevated, and approaches the teeth of the upper jaw. O requires the tongue to be depressed, and the lips contracted; and in the pronunciation of U, the lips must be still more contracted, and somewhat extended. The first consonants articulated by children are those which require the least motion of the organs. B, M, and P, are most easily pronounced. B and P require only the lips to be joined, and then opened with celerity; and for M, they must be first opened, and then quickly shut. The articulation of the other consonants cannot be effected without more complicated movements. The pronunciation of C, D, G, L, N, Q, R, S, and T, depends upon particular motions of the tongue, which are not easily described. F requires a prolongation of sound beyond any of the

other consonants. Thus, if the vowel A is most easily pronounced; and [illegible] P and M. It is for [illegible] all countries, first begin [illegible], *Papa, Mama.* The [illegible] most natural, only because [illegible] easily pronounced; and the letters of which they are composed must exist in every language.

It is worthy of remark, however, that, as the sounds of several consonants are very similar, as those of B and P, of C and S, of K and Q, of D and T, of F and V, of G and J, of G and K, and of L and R, there may be many languages in which these different consonants are not employed. But in every language a B or a P, a C or an S, a K or a Q, a D or a T, an F or a V, a G or a J, an L or an R, are indispensible; and, in the most contracted alphabets, there must be at least six or seven consonants; because the articulation of them is not complicated, and the sounds by which they are uttered are all distinct and different from each other. Children who cannot easily pronounce R, substitute L in place of it, and T in place of D; because the former are more difficult to articulate than the latter: and the softness or harshness of a language depends on the choice of consonants which are more or less difficult to pronounce. But it is needless to enlarge upon this subject.

Some children, at two years of age, articulate distinctly, and repeat whatever is said to them; but most children require a long time. It has been remarked, that those who are long before

they beg... to speak, never articulate with the same ... who acquire that faculty m... ... may be taught to read before ... years of age; and I have known c... ...ngly at four. But, after all, it is ... determine whether any advantages a... ...ived from such premature instruction. We have had so many examples of prodigies of learning at four, at eight, at twelve, and at sixteen years, who turned out to be either fools, or men of very little ability, at twenty-five, that I am inclined to think, that the common mode of education, by which Nature is not prematurely forced, and which is discreetly proportioned to the strength and capacity of children, is still the best.

MAHARAJA SERFOJI'S ... MAHAL. THE TANJORE

SECT. III.

Of Puberty.

PUBERTY commences where childhood ends, and accompanies us through the after periods of life. Before puberty, Nature seems to have had nothing in view but the growth and preservation of her work. The provision she has made for the infant extends no farther than the nourishment and expansion of its members. It lives, or rather enjoys a kind of vegetable existence, which is confined to itself, and which it cannot communicate. But the principles of life soon multiply: we are soon possessed of a stock, sufficient not only for our own being, but for enabling us to bestow existence upon others. This redundancy of life, the source of health and vigour, can no longer be confined, but is strongly impelled to expand and diffuse itself. The age of puberty is accompanied with several external and internal marks. It is the spring of life; the season of pleasure. May we be enabled to write the history of this critical period, without exciting any ideas but what are strictly philosophical! In the history of man, puberty, circumcision, castration, virginity, impotence, and many other circumstances, are articles too essential to be omitted. We shall, therefore, endeavour to de-

scribe them with that delicacy of style, that philosophical apathy, which annihilate every loose desire, and bestow on words nothing more than their simple and primitive signification.

Circumcision is a custom of great antiquity, and is still practised over the greatest part of Asia. Among the Hebrews the operation was performed eight days after birth. In Turkey it is delayed to the seventh or eighth year, and sometimes to the eleventh or twelfth. The children in Persia are circumcised at the age of five or six; the wound is healed with caustic or astringent powders; and burnt paper is very generally used, which, according to Chardin, is the best remedy. This author tells, that the operation, when performed on grown persons, is attended with considerable pain: that they are obliged to be confined to the house three or four weeks; and that death is sometimes the consequence.

In the Maldivia islands, children are circumcised at the age of seven years. To render the skin soft, the children are bathed in the sea six or seven hours before the operation. The Israelites made use of a sharp stone; the Jews observed the same mode in most of their synagogues. But the Mahometans employ a knife or a razor.

An operation similar to circumcision is necessary in certain diseases. It is a common opinion, that the prepuces of the Turks, and of other nations where circumcision is practised, would naturally grow too long, if they were not curtailed in childhood. Boulaye says, that he has seen, in

the deserts of Arabia and Mesopotamia, on the banks of the Tigris and Euphrates, numbers of Arabian boys, whose prepuces were so long as to render them incapable of generation without the aid of circumcision.

The people of the east have likewise longer eyelids than the inhabitants of other nations. The skin of the eyelids resembles that of the prepuce. But what relation can take place between the growth of those distant parts?

Girls as well as boys are circumcised upon the borders of the Persic Gulf and the Red Sea. But these people never perform the operation till the girls have passed the age of puberty; because there is no redundance before that period. In other climates, the excess of growth in the nymphæ appears more early; and is so general among certain people, as those upon the river Benin, that they circumcise both girls and boys eight or ten days after birth. The circumcision of females was an ancient custom even in Africa. Herodotus mentions it among the usages of the Æthiopians.

Circumcision may, therefore, be founded on necessity; it has, at least, propriety for its object. But *infibulation* * and castration must have arisen from jealousy alone. These ridiculous and cruel operations have been invented by gloomy and fanatical tyrants. who, actuated by a mean envy, and a desire of monopolizing natural plea-

* This word signifies the operation of tying or sewing parts together.

sures, enacted and enforced those barbarous and bloody laws, which make privation a virtue, and mutilation meritorious.

Boys are infibulated by drawing the prepuce forward, piercing it, and putting a small cord through the holes, which remains till the cicatrice of the opposite sides be formed: the cord is then removed, and a ring substituted in its place, which is made of sufficient strength to last as long as the person who ordered the operation pleases; and sometimes it remains for life. The eastern monks, who take on the vow of chastity, employ a large ring, which renders a breach of their oath impossible. We shall afterwards mention the method of infibulating females. It is impossible to imagine any thing too ridiculous upon this subject, which has not been practised by some men, either from motives of passion or of superstition.

During infancy, there is sometimes but one testicle in the scrotum, and sometimes none. We must not, however, conclude that children in this situation are totally destitute of these parts. It often happens, that the testicles remain in the abdomen, or are entangled in the rings of the muscles. But time generally removes these obstacles; and the testes descend into their proper receptacle at the age of eight or ten, and sometimes not till the season of puberty. Parents, therefore, have no reason to be anxious about such of their children as seemingly have no testes, or but one. The testicles of adults are seldom concealed; because nature, at the age of puberty,

makes strong efforts to bring them to light. The same effect is sometimes produced by disease, or violent motion, such as a leap, a fall, &c. Even when the testicles never make their appearance, the purposes of generation are not frustrated. Men of this kind are often endowed with uncommon vigour.

There are men who have but one testicle. This defect, however, is inoffensive; for it is always uncommonly large. Some men have three, and are, on that account, said to possess more vigour and bodily strength. We learn, from the animal creation, how greatly these parts contribute to strength and courage. How different is an ox from a bull, a wedder from a ram, and a capon from a cock!

The practice of castration among mankind is very extensive, and of great antiquity. It was the punishment of adultery among the Egyptians. In the Roman dominions, the number of eunuchs was considerable: at this day, these mutilated males are employed through all Asia and part of Africa, as guards upon the chastity of the ladies. In Italy, this infamous, this cruel operation, has nothing for its object but the improvement of the voice. The Hottentots cut off one testicle, because they imagine that this operation renders them more swift in the chase. In other countries, the poor people mutilate their children, to make them incapable of procreation, and to prevent them from feeling those excruciating pangs which they themselves suffer, when they want bread to support their offspring.

The species of castration vary according to the

object in view. When the improvement of the voice is intended, the two testicles are only cut out. But men, whose minds are inflamed with jealousy, would not believe their females to be safe in the custody of such eunuchs: they employ none but such as have been deprived of the whole external parts of generation.

But amputation is not the only means of accomplishing this end. Formerly, the growth of the testicles was prevented, and their structure destroyed, without any incision: they bathed the infants in warm water and decoctions of plants, and then pressed and rubbed the testicles for a long time, in order to destroy their texture. Others compressed them with an instrument: some pretend, that this species of castration does not endanger life.

The amputation of the testicles is not very dangerous: it may be done at any age; the time of infancy, however, is always preferable. But the amputation of the whole external parts of generation is often fatal, especially if performed after the age of fifteen years. Even in the most favourable time, which is from seven to ten years of age, there is always great danger. The difficulty of preserving eunuchs of this kind renders them exceedingly precious. Tavernier informs us, that, in Turkey and Persia, they bring five or six times the price of the other kind. Chardin observes, that the total amputation is accompanied with the most exquisite pain; that it is performed pretty safely upon young children; and is exceedingly dangerous after the age of fifteen; that hardly a fourth part escape with life; and

that the wound is never cured in less than six weeks. On the other hand, Pietro della Valle asserts, that those who suffer this punishment in Persia for rapes, and other crimes of that nature, heal easily, though advanced in years; and that they apply nothing but ashes to the wound. I know not whether those who underwent the same punishment in Egypt, as Diodorus Siculus relates, escaped with equal ease. According to Thevenot, vast numbers of negroes, who are forced by the Turks to submit to this operation, perish, even when it is performed on children of eight or ten years of age.

Beside negro eunuchs, there are others at Constantinople, throughout all Turkey, Persia, &c., who, for the most part, are brought from the kingdom of Golconda, the peninsula on this side the Ganges, the kingdoms of Assan, Arracan, Pegu, and Malabar, where their colour is gray; and from the Gulf of Bengal, where they are of an olive colour: there are some white eunuchs from Georgia and Circassia; but their number is small. Tavernier says, that, when he was in the kingdom of Golconda, in the year 1657, 22,000 males were castrated. The black eunuchs come from Africa, and especially from Æthiopia. In proportion to the ugliness and horror of their appearance, they are the more esteemed, and bring a higher price. A very flat nose, a frightful aspect, large thick lips, and, above all, black teeth, placed at a great distance from each other, are admired qualities in a eunuch. These people have commonly fine white teeth: but such teeth

would be a capital defect in a eunuch, who ought to be a hideous monster.

Eunuchs, who are only deprived of their testicles, have a lively sense of titulation in what remains: they have even the external sign more frequently than other men. The part which remains, however, is generally small; for it continues nearly in the same state in which it was before the operation. A eunuch castrated at seven years of age, when arrived at twenty, is no better, with regard to this matter, than a child of seven. Those, on the other hand, who have not undergone the operation till the age of puberty, or later, have parts nearly equal to those of sound men.

Peculiar relations subsist between the throat and the parts of generation, though we are totally ignorant of their causes. Eunuchs have no beard; their voice, though strong and piercing, can never reach a low or deep tone. Secret diseases often appear in the throat. The remarkable sympathy which some parts of the body have with others, though at a distance, and of a different nature, is a subject too much neglected: we are apt to despise effects, when we cannot easily discover their causes. Hence it is, that we never think of examining these relations or sympathies, although they are the proper spring of the animal constitution. In females, there is a remarkable sympathy between the uterus, breasts, and head. How many curious and useful facts of this nature might be discovered if physicians paid more attention to this interesting subject! It would pro-

duce more enlightened views, and a more extensive utility, than can ever be expected from a mere register of anatomical names. It is impossible to discover the principles of animal motion: the springs which give life to organization are not to be found in the muscles, veins, arteries, and nerves, described with such minuteness by anatomists. Organized bodies are possessed of internal powers, upon which the gross laws of mechanism have no influence. Instead of attempting to discover these powers, by attending to their effects, they have been treated as ideal existences; they have ceased to be the objects of philosophical research. They have at last reassumed their native importance in the laws of gravitation, in elective attractions, in the phænomena of electricity, &c. But, notwithstanding the evidence and universality of their existence, as their action is internal, as they are solely objects of reason, and have little connexion with the senses, they are in danger of escaping our observation, and we admit them with difficulty; for judgment is generally occupied and directed by external objects. We never imagine that the internal constitution of animated beings ought to be a principal object of inquiry. We conceive that the human genius is limited to external objects; and, therefore, we overlook every thing that might lead to a more refined and spiritual philosophy.

The ancients, less limited in genius, and possessed of a more comprehensive philosophy, were not astonished to meet with facts which were inexplicable: they viewed Nature through a more

transparent medium. A peculiar correspondence or sympathy, was to them only a phænomenon; but to us, because not reducible to some fanciful laws of motion, it is a paradox. They knew that Nature produced her principal effects by laws concealed from human eyes: they knew, that, to trace her various laws and modes of operation, exceeded the powers of our circumscribed faculties. A certain number of uniform and related effects, therefore, was to them sufficient to constitute a cause, or law of Nature. Whether, according to the ancients, this sympathy shall be called a peculiar correspondence between different parts of the body, or, according to the moderns, it shall be considered as an unknown relation in the action of nerves, its existence in the animal economy is universal; its effects, therefore, are of the utmost importance to the theory of medicine, and cannot be too diligently scrutinized. But this is not the place for a full investigation of such an important subject. I shall only observe, that the relation between the voice and the generative organs takes place not only in eunuchs, but in other men: it is even discoverable in females. In men, the voice changes at the age of puberty; and in women who have a strong rough voice, the passion of love is suspected to be violent.

The first symptom of puberty is a sense of fulness and stiffness in the groins, which is most perceptible when walking, or when the body is bent forward. This stiffness is often accompanied with pretty smart pain in the different joints

of the limbs: it is likewise accompanied with a new and peculiar sensation in those parts which distinguish the sexes. Small whitish tubercles also begin to appear in these parts, which are the germs of their natural veil. The voice, for a considerable time, is rough and unequal; after which it becomes more full, articulate, and strong. This change is very conspicuous in boys; but it is less distinguishable in girls, because their voices are naturally more sharp.

These marks of puberty are common to both sexes: but each sex has marks peculiar to itself; as the eruption of the menses and the expansion of the breasts in women; the beard and faculty of procreating in men. These marks, indeed, are not always uniform. The beard, for example, does not always appear precisely at the age of puberty: there are even whole nations who have hardly any beard. On the contrary, there is no country where the age of puberty in women is not distinguished by the enlargement of the breasts.

Among every race of mankind, the females arrive at puberty sooner than the males. But the age of puberty is very different in different countries. It seems to depend upon the temperature of the climate and the quality of the food. The children of citizens and of opulent parents, who are generally fed with rich and nourishing victuals, arrive sooner at this state. But children brought up in the country, or whose parents are poor, require two or three years longer; be-

cause their food is not only bad, but given too sparingly. In the southern parts of Europe, and in cities, girls arrive at puberty about the age of twelve, and boys about fourteen. But in northern climates, and in the country, girls hardly come to maturity till they are fourteen, and boys not before sixteen.

It may be asked, why are the females, in all climates, capable of procreating sooner than the males? The answer is easy: the bodies of men are larger and stronger; their bones are harder, and their muscles more compact; a longer time is therefore necessary for their growth. Besides, as the growth of the body must be nearly complete before a superfluous quantity of organic juices can be accumulated in the parts destined for generation, women, of course, must arrive at maturity sooner than men.

In the warmest climates of Asia, Africa, and America, the age of puberty commences in girls at ten, and sometimes at nine. The periodic discharge, though less abundant in warm climates, appears much sooner. The interval is nearly the same in all nations. With regard to time, a greater diversity takes place between individuals than between nations. In the same climate and nation, some females suffer this evacuation every fifteen days; others have an interval of six weeks; but a month, or a few days more or less, is the most usual period.

The quantity evacuated seems to depend upon the quantity of nourishment and of insensible

perspiration. The discharge is greatest in females who eat largely and take little exercise: it is least in warm countries, where the perspiration is more copious. The quantity of this discharge has been variously estimated. It is, indeed, difficult to make an accurate measure. In different subjects, and different circumstances, it varies from one or two ounces to a pound, and even more. It generally continues to flow three, four or five days; but sometimes it remains for six, seven, and even eight days. The cause of this discharge is generally ascribed to a superfluity of bloody and nutritious juices. The symptoms which precede it are certain indications of a plethora, as heat, tension, swelling, and the pains felt not only in the parts themselves, and their environs, but in the mammæ, which also swell and discover a superabundance of blood by the colour of the areolæ becoming then more deep: the eyes likewise are heavy, and the skin below the orbits takes on a faint blue or a violet colour: the cheeks glow; the head is heavy and affected with pain; and, in a word, the whole body is oppressed with a surcharge of blood.

The growth of the body, in length, generally terminates at the age of puberty. Before this period, young people commonly shoot up several inches in a very short time. But the quickness of growth is most remarkable in the parts of generation of both sexes. In males, this growth is only an augmentation in size: but, in females, it often produces a shrinking of some of the

parts, which has received different appellations from those who have treated of the signs of virginity.

Men, jealous of preeminence of every kind, have always discovered a remarkable attachment to prior and exclusive possessions. This species of folly has bestowed a physical existence upon female virginity. Virginity, which is a moral being, a virtue existing solely in purity of heart, has been metamorphosed into a physical object, in which most men think themselves deeply interested. This notion, accordingly, has given rise to many absurd opinions, customs, ceremonies, and superstitions; it has even given authority to pains and punishments, to the most illicit abuses, and to practices which shock humanity. Young women have been obliged to submit to the examinations of ignorant matrons, and to expose the secrets of Nature to the eyes of prejudiced physicians. They did not reflect, that every indecency of this kind is a violent attack against chastity; that every situation which produces an internal blush, is a real prostitution.

I have little hope of being able to eradicate the ridiculous prejudices which have been formed on this subject. Mankind always believe what they wish to be true, however vain and unreasonable the foundations of their faith. But, as it is the province of history to relate not only the succession of events, and the circumstances of facts, but likewise the origin of popular opinions and

errors, I think it a necessary article in the history of man to examine this favourite idol which he adores, to consider the reasonableness of his worship, and to inquire whether Virginity be a real or a fabulous divinity.

Fallopius, Vesalius, Diemerbroek, Riolan, Bartholin, Heister, Ruysch, and some other anatomists, maintain, that the membrane of the hymen has a real existence, and that it ought to be reckoned among the parts of generation peculiar to females. They assert that it is a fleshy membrane, very thin in infants, but thicker in adults; that it is situated under the orifice of the urethra, and nearly shuts up the entrance of the vagina; that it is perforated by a round or oval hole, so small as hardly to admit a pea during infancy, or a large bean at the age of puberty. The hymen, according to Winslow, is a membranous fold, sometimes circular, and sometimes semilunar, with an aperture of a smaller or greater size in different subjects, &c. On the other hand, Ambrose Paré, Dulaurent, De Graaff, Pineus, Dionis, Mauriceau, Palfyn, and other anatomists of equal authority with those formerly mentioned, insist, that the membrane of the hymen is a mere chimera; that it is not natural to young girls; and express their astonishment that any man should talk of it as a thing which has a real and uniform existence. They produce a multitude of experiments and observations made upon subjects of different ages, in which they could never discover any appearance of this membrane. They acknowledge, that they have sometimes, but very

seldom, seen those fleshy protuberances, called carunculæ myrtiformes, connected by a membrane; but they maintain, that this membrane was preternatural. Anatomists are not less divided with regard to the number and qualities of these carunculæ. Are they only rugosities of the vagina? Are they distinct and separate parts? Are they the remains of the hymen? Is their number uniform? Does only one, or many, accompany the state of virginity? All these questions have been stated, and each has received a different solution.

This opposition of sentiment, in a matter which depends on inspection, is an incontestible proof, that mankind have often an ardent desire to discover things in Nature which exist in their own imaginations only. Many anatomists of reputation have never been able to discover either the hymen or carunculæ, even before the age of puberty. Those who support the contrary opinion, at the same time acknowledge, that these parts are not always the same; that their form, size, and texture, vary in different subjects; that, in place of the hymen, sometimes there is but one caruncula, at other times there are two or more united by a membrane; that the shape of the aperture is not uniform, &c. What is the consequence? We must conclude, that the causes of this mark of virginity are equivocal and inconstant; and that, even when they have existence, they produce only an effect of a transient and variable nature. Anatomy determines nothing with regard to the existence of the hymen and

carunculæ; it allows us to reject these symptoms of virginity, because they are not only uncertain, but imaginary.

The effusion of blood, though a more common symptom, is not less equivocal. It has, in all ages, been regarded as an infallible proof of virginity. But it amounts to nothing in all those cases where the entrance of the vagina is naturally relaxed or dilated. Besides, the effusion of blood is not peculiar to virgins. Women who have no pretensions to virginity frequently experience this discharge. Some discharge copiously, and often; others a small quantity, and only once; and some have no such effusion. This phænomenon depends upon age, health, structure of parts, and a number of circumstances. Of these we shall enumerate only a few, and endeavour, at the same time, to investigate the true causes of the various physical marks which have been held forth as infallible characteristics of female virginity.

At the time of puberty, the parts of both sexes undergo a considerable change: those of the male have then a growth so quick, that they arrive in a year or two at full maturity. Those of women increase likewise at this period. The nymphæ, in particular, which, though formerly almost imperceptible, now become full and conspicuous. The menstrual discharge appears at the same period. By an unusual accumulation of blood, all the parts swell, and approach towards each other. The orifice of the vagina contracts, though the dimensions of the vagina

itself be enlarged. The appearances produced by this contraction are different in different subjects; for we are informed by anatomists, that there are sometimes four, and sometimes only three, or two, carunculæ; and that a circular or semilunar ring, or rather a series of folds, is a common phænomenon. But anatomists have neglected to tell us, that, whatever form this contraction assumes, it never appears before the age of puberty. In young girls whom I have had occasion to dissect, nothing of this kind could be discerned; and, having collected many facts concerning this subject, I can with confidence assert, that when young women, before puberty, have commerce with men, no effusion of blood ever happens, unless the parts be greatly disproportioned, or some violence is committed. On the other hand, at the time of puberty, especially when the females are regular, and in good health, these effusions are common, and produced by the slightest causes. But those who are meagre, and subject to the fluor albus, generally want this mark of virginity. The frequent repetition of this flux of blood, and even at considerable intervals of time, is an evident demonstration that it is only a deceitful appearance. It is a certain fact, that young women, who at first had a copious effusion, have repeated this pretended symptom of virginity after a few months' abstinence. This phænomenon, may, by proper management, be frequently exhibited, especially before the body has acquired its full growth. It is equally certain, that young wo-

men, who have not been faithful to the marriage bed, have, notwithstanding, by the simple expedient of abstinence, given fresh proofs of innocence to their deluded husbands. Some women, in the course of two or three years, have exhibited this fictitious mark of purity five times. But this symptom is limited to a certain time; for it seldom appears after the age of eighteen years. When the growth of the body is completed, its parts become fixed and unalterable, and cannot assume differences but by the employment of such artifices as it would be both unnecessary and improper to relate. Besides, many women, particularly those who are irregular in their menses, and subject to the fluor albus, never have any fresh marks of virginity.

Nothing, therefore, can be more chimerical than the prejudices of men with regard to virginity, and nothing can be more fallacious than its pretended signs. A young woman may have commerce with a man before the age of puberty, and yet exhibit no marks of virginity. But the same woman, after she arrives at puberty, may have very copious effusions of blood. Others, who are [illegible]ual virgins, di[illegible]cover no such appearances. Men, therefo[illegible]ould be perfectly easy as to this matter, [illegible]not indulge, as is too often the case, unjus[illegible] and ridiculous suspicions.

If we wish to obtain an evident and infallible mark of virginity, we must search for it among those barbarous people, who are incapable of instilling by education the sentiments of virtue

and honour into their children, but secure the chastity of their daughters by an expedient which could only be suggested by the rudeness of their manners. In Æthiopia, and other parts of Africa, in Pegu, Arabia Petrea, and other nations of Asia, the inhabitants, immediately after the birth of females, sew up those parts which Nature has separated, leaving only a space sufficient for the natural evacuations. As the child grows, the parts gradually adhere, and, when the time of marriage arrives, they are again disunited by incision. Instead of thread, the fibres of the asbestos are said to be employed, which is a substance not liable to sudden corruption. Some tribes content themselves with putting a ring through the parts. To this operation wives as well as girls are subjected, with this difference, that the ring allotted to the latter cannot be removed, but in that allotted to the former, there is a lock, of which the husband alone possesses the key. But why should we mention barbarous nations, when we have similar examples at no great distance? That absurd delicacy of a neighbouring nation, with regard to the chastity of their wive[illegible] is the offsp[illegible] of a brutal and criminal jeal[illegible]

How opp[illegible]re the tastes, the dispositions, the opinions, [illegible] the manners of different nations? After what has been related concerning the high estimation of virginity among the bulk of mankind, and the numberless precautions and ignominious methods employed to secure it, is it possible to believe that there are other people who

despise virginity, and consider the trouble of removing it to be a mean and servile office?

* Superstition has induced the inhabitants of certain countries to resign the first fruits of virginity to their idolatrous priests, and sometimes to the idols themselves. This privilege is enjoyed by the priests of Cochin and of Calicut; and, in Goa, the virgins are prostituted by their parents, either voluntarily or from choice, to an idol of iron. Gross superstition induces these people to commit such abominable outrages from religious motives. But views more servile and interested have induced men of other countries to devote their daughters to their chiefs. The inhabitants of the Canary isles, and of the kingdom of Congo, prostitute, in this manner, their daughters, without any injury to their reputation. Nearly the same custom takes place in Turkey, Persia, and several other countries both of Asia and Africa. Their most eminent nobles think themselves highly honoured to receive from their sovereign, women with whom he himself is already disgusted.

In the kingdom of Arracan, and in the Philippine islands, a man would esteem it to be disgraceful to marry a young woman who had not been previously deflowered; and nothing but the force of money can prevail on any person to precede the husband. In the province of Thibet, mothers anxiously search for strangers, and earnestly solicit them to put their daughters in a proper state for obtaining husbands. The Laplanders likewise prefer girls who have had

commerce with strangers. They fancy them to possess uncommon merit, because they have been able to please men who are better judges of beauty and female accomplishments than themselves. In Madagascar, and several other countries, the most dissolute and debauched women are soonest married. Many other examples might be given of this strange taste, which nothing but the grossest and most depraved manners could produce.

After puberty, marriage is the natural state of man. A man ought to have but one wife, and a woman but one husband. This is the law of nature; for the number of females is nearly equal to that of males. Such laws as have been enacted in opposition to this natural principle, have originated solely from tyranny and ignorance. Reason, humanity, and justice revolt against those odious seraglios, in which the liberty and the affections of many women are sacrificed to the brutal passion of a single man. Does this unnatural preeminence render these tyrants of the human race more happy? No! Surrounded with eunuchs, and with women useless to themselves and to other men, they are tormented with the constant appearance of that accumulated load of misery they have created.

Marriage, therefore, as it is established among us, and other nations who are directed by the lights of reason and revelation, is a state most consonant to the nature of man, and in which it is his duty to employ those new faculties he ac-

quires from puberty. By obstinately persisting in celibacy, these powers become troublesome, and sometimes fatal. In either sex, too long continency may give rise to diseases, or create irritations so violent, that neither reason nor religion may be able to counteract the impetuosity of those passions they excite; and thus man may be reduced to a level with the brutes, who, under the influence of such sensations, become perfectly furious and ungovernable.

In women, the furor uterinus is the most violent effect of this irritation. This disease is a species of madness, which deranges their ideas, and deprives them of all sense of shame. Both the nature and the seat of this melancholy distemper are indicated by the most lascivious expressions, and the most indelicate actions. I have seen, with astonishment, a girl at the age of twelve years, who had a brown, but lively and florid complexion, and, though low in stature, was strong and plump, commit the most indecent actions upon the very appearance of a man, from which she could not be deterred, either by the presence or chastisement of her mother. She did not, however, lose her reason; and the paroxysms of the disease ceased, the moment she was left with her own sex. Aristotle alleges, that, at this age, the irritation is strongest, and that girls ought then to be carefully watched. The remark may be applicable to the climate in which he lived; but, in colder countries, the ardor of the female constitution does not appear so early.

When the furor uterinus increases to a certain degree, marriage will not remove it; and there have been instances of its proving fatal. Happily the force of nature is seldom the only cause of a passion so detestable, even when there is a predisposition to it in the habit of body. Before arriving at this extremity, the imagination must be inflamed by licentious conversation, by obscene representations, or other causes. Among women, the opposite temperament is infinitely more common; for, with regard to this passion, most of them are either cool or indifferent. There are also many men to whom chastity is an easy virtue. I have known some men who, at the age of twenty-five or thirty, enjoyed good health, without having ever felt this passion so strong as to render any gratification necessary.

Continency, however, is less to be dreaded than excess. The number of immoderate men is too great to require particular examples. By excess, some have lost their memory; some have been deprived of sight; some have become bald; and many have perished by pure debility. Young persons can never be sufficiently warned of the irreparable injury to their health, which the indulgence of the venereal appetite never fails to produce. How many cease to be men, or, at least, cease to enjoy the powers of manhood, before the age of thirty? And how many, at fifteen or eighteen, receive the seeds of a disease, disgraceful in itself, and which it is often impossible to eradicate?

It has already been remarked, that, at the age

of puberty, the growth usually stops. It frequently happens, however, that, even after puberty, a tedious illness makes the body increase in length more than it would have done in a state of perfect health. This extraordinary increase is probably occasioned by the inactivity of the external organs of generation during the course of the disease. The organic particles do not reach these parts, because they are not determined thither by irritation; and this defect of irritation is owing to a lassitude and imbecility of the parts, which prevent the secretion of the seminal fluid. These organic particles, therefore, remain in the mass of blood, and necessarily extend the extremities of the bones nearly in the same manner as happens to eunuchs. Thus young people, after recovering from a long sickness, are often taller, but worse shaped than formerly. Some, for instance, become hunch-backed, and others crook-legged; because the still ductile extremities of the bones have been unnecessarily extended by a superfluity of organic particles, which, in a state of health, would have been exhausted in the formation of seminal fluid.

The production of children is the chief intention of marriage. But this intention is sometimes frustrated. Of the different causes of sterility, some are common to both sexes. But as these causes are more apparent in men than in women, they are, therefore, more commonly ascribed to the former. In both sexes, sterility is occasioned either by a defect in the original conformation, or by accidental injuries done to the organs them-

selves. In men, the most pernicious defects of conformation are those which affect the testicles, or the muscles called *erectores penis*. A wrong direction of the urethra, which is sometimes not only oblique, but improperly perforated, is another obstacle to generation. The adhesion of the prepuce to the frænum is another obstacle: but it is not insurmountable. In women, the conformation of the uterus may likewise occasion sterility. If the orifice of the uterus be always open, or always shut, conception will be equally prevented. But the most frequent cause of barrenness, both in men and women, arises from some depravity in their seminal fluids. I formerly quoted a remark of Valisnieri, that a corruption of the fluid in the testicles of women rendered them entirely barren. It is the same with men. If the secretion by which semen is formed be vitiated, the fluid is unfit for impregnation. The causes of sterility are not discoverable by any external appearances.

In cases of sterility, different means have been employed to discover whether the defect proceeded from the man or the woman. Inspection is the first resource; and, if the barrenness be occasioned by a fault in the external conformation, it is sufficient. But, if the defect lie in the internal organs, it is hardly possible either to discover or remove it. Some men, though they appear to be perfectly formed, want the genuine sign of a proper conformation. Others have this sign so imperfectly, or so seldom, that it is only a very equivocal mark of virility.

Every body knows that the action of this part is not under the command of the mind. It is the most animal part of the human body; for it acts by a kind of instinct, the causes of which are unknown. How many young persons, educated in perfect purity, and totally ignorant of pleasure, have felt the most lively impressions, without being able to recognise either their cause or their object? How many, on the contrary, remain cold and languid, notwithstanding all the efforts of sense and imagination?

This part of our bodies, therefore, belongs less to us than any other of our members. It acts or is languid without our participation. Its functions commence or terminate at certain periods. All this happens without our command, and often contrary to our inclination.

Where, then, is the foundation for these laws, which are so unjust in their principle, and so disgraceful in their execution? The rules and decrees of the Congress* are an affront to human reason. Its members should have known, that the very means they employed to investigate truth, were not only indelicate, but infallibly prevented its discovery.

When there is no defect in the external confor-

* The name of an infamous court in France, where trials for impotency, with a view to dissolve marriages, were held. Proofs by inspection were taken before the judge, who was assisted by surgeons aud midwives. This court was abolished by an arret of the parliament of Paris, dated 18th of February, 1677. It is surprising that the Count de Buffon, who expresses the utmost detestation against this court, should have mentioned nothing of its dissolution.

mation, barrenness proceeds oftener from the woman than the man; for, independent of the pernicious effects of the fluor albus, there seems to be another cause, which has never excited attention.

From my experiments, related in the sixth chapter, it appears that the testicles of females give birth to a kind of natural protuberances, which I have called *glandulous bodies*. They grow in a gradual manner, and serve for secreting and maturating the seminal fluid. They are in a continual fluctuating state. They begin to grow under the membrane of the testicle, which they soon perforate; they then swell, and their extremities spontaneously open, and distil a seminal fluid for some time; after which they gradually decay, leaving only a small reddish cicatrix on the place from whence they sprung. These glandulous bodies no sooner disappear than they are replaced by others; so that the testicles are continually labouring, and undergoing considerable changes. Hence any derangement in these organs, either by an unusual thickness of the fluid, or weakness of the vessels, prevents the proper exercise of their functions, renders them unable to secrete, or rather vitiates and corrupts the seminal fluid, which necessarily gives rise to sterility.

Conception sometimes precedes puberty. Many women have become mothers before the appearance of the menses; and some who never had any symptoms of this evacuation, are in the habit of bearing children. Instances of this kind

happen in our climate, without travelling for them to Brazil, where whole nations are said to be perpetuated, though not a single woman be subject to the menstrual discharge; an evident proof that it is not the menstrual blood, but the seminal fluid of the male and female, which are essentially necessary to generation. It is likewise known, that the cessation of the menses, which generally happens about the age of forty or fifty years, does not disqualify every woman for conception: for some women have become pregnant at sixty or seventy, and even at an age still more advanced. These examples, though pretty frequent, may be regarded as exceptions to the general rule; but they are sufficient to demonstrate that the menstrual blood is by no means essential to generation.

In the ordinary course of Nature, women conceive not before the menses appear, nor after they have ceased. The age at which men first acquire the faculty of generating is not so distinctly marked. His body must attain a certain growth before semen is secreted; and, before this fluid be fully maturated, the degree of growth must be still greater. This generally happens between the twelfth and eighteenth years. But the period when man loses the generative faculty, Nature seems to have left undetermined. At sixty or seventy, when old age begins to enervate the body, the semen is less abundant, and often unprolific.' In the collections of public societies, however, there are many instances of men who

have continued to procreate at the age of eighty or ninety.

There are likewise examples of boys who have procreated at eight, nine, and ten years, and of girls who have conceived at seven, eight, and nine years. But such facts are exceedingly rare, and ought to be regarded as singular phænomena. The sign of virility appears in infancy: but that is not sufficient; the production of semen must be added; and this happens not till the growth of the body is nearly completed. At first the quantity is small, and generally sterile.

Two marks of conception have been mentioned by authors. The first is a kind of tremor, or shivering, which is said to begin at the moment of conception, and continues for some days. The second is derived from the orifice of the uterus, which, it is asserted, closes entirely after conception. But these signs appear to be very equivocal, if not altogether imaginary.

This tremor is mentioned by Hippocrates in the following terms: "Liquido constat harum rerum peritis, quod mulier, ubi concepit, statim inhorrescit ac dentibus stridet, et auriculam reliquumque corpus convulsio prehendit." Galen, on the authority of some women, imputes this symptom to the contraction of the uterus. Others express it by a vague sensation of cold over the whole body, and employ the words *horror* and *horripilatio*. These, and other authors, endeavour, like Galen, to establish the fact upon the testimony of women. Hippocrates says, "quæ

in utero gerunt, harum os uteri clausum est;" or, according to another translator, "quæcunque sunt gravidæ, illis os uteri connivet." Opinions, however, are various as to the changes which the uterus undergoes after conception. Some maintain, that the edges of the os tincæ are drawn so close together, that no vacuity is left between them; and others affirm, that these edges are not exactly close till after the two first months of pregnancy. They agree, however, that, immediately after conception, the orifice is shut up by a glutinous humour; that the os tincæ, which, previous to conception, might admit a substance of the size of a pea, has no perceptible aperture; and that this difference is so evident, as to be distinguishable by a skilful midwife. If these assertions were founded in truth, the state of pregnancy might be known a few days after conception.

It is urged, on the other hand, that if, after conception, the orifice of the uterus were closed, superfœtation would be impossible. To this it may be replied, that the seminal liquor may perhaps penetrate through the membranes of the uterus: that the uterus itself may open to receive the materials necessary for superfœtation; and that, at any rate, superfœtations so seldom happen, that they make a very trifling exception to the general rule. Other authors maintain, that this change in the uterus can never appear but in women who have formerly conceived and brought forth children. In first conceptions, indeed, the difference must be less perceptible; but, though

ever so conspicuous, we have not sufficient evidence to conclude, that it is a certain, a uniform, and a positive sign. The study of anatomy, aided by experience, affords, on this subject, general notions only, which vanish upon a closer examination. The same observation may be applied to the shivering, or convulsive cold, which some women are said to feel at the time of conception. As most women do not experience this sensation; as others, on the contrary, assure us that they have felt a burning heat; and as others still confess that they are utter strangers to all such feelings; the natural conclusion is, that all these marks are highly equivocal, and that, when they do happen, they ought to be considered, not as the effects of conception, but of other causes.

On this subject I shall add one fact from Mr. Parson's Lectures on muscular Motion, p. 79, which proves, that the orifice of the uterus does not close immediately after conception, or, if it does close, that the semen may find a passage into the uterus, by penetrating its substance. In the year 1714, a woman of Charlestown in South Carolina, was delivered of two children, the one immediately after the other. To the astonishment of the assistants, the one child was black and the other white. This evident testimony of the woman's infidelity to her husband, obliged her to acknowledge, that, one morning, her husband having just left her bed, a negro entered her chamber, and, by threats of immediate death, compelled her to gratify his desires. This fact shows, that the conception of two or more

children does not always happen at one time, and supports my opinion, that the semen penetrates through the texture of the uterus.

There are many other equivocal signs of pregnancy, by which it is said to be early distinguishable; as a slight pain in the region of the uterus and loins; a numbness over the whole body; a continual drowsiness; a melancholy and capricious disposition; the toothach, headach; and a vertigo, which obscures the sight; yellowish, blood-shot eyes, with contracted pupils and depressed eye-lids; a pale and spotted countenance; a depraved appetite, accompanied with vomiting and spitting; hysteric symptoms; the fluor albus; the stoppage of the menstrual discharge, or, instead of it, an hæmorrhage; the secretion of milk in the breasts, &c. Many other marks, supposed to be peculiar to pregnancy, might be added; but they are frequently nothing more than the effects of particular diseases. But we shall leave the discussion of these to physicians. Details of this kind, to be useful, would require a long series of profound investigation. This subject, like many others in physiology, in the animal economy, and in different branches of the medical art, has seldom been treated with any degree of philosophical accuracy.

SECT. III.

Of Manhood.

AT the age of puberty, or a few years after it, the human body attains its full stature. The growth of some persons stops at the fourteenth or fifteenth year; and, in others, it continues till they arrive at twenty-two or twenty-three years. During this period, most men are of a slender make: their thighs and legs are small, and the muscular parts are not properly filled up. But, by degrees, the muscles swell, the limbs and different parts of the body assume their proper figure and proportions, and, before the age of thirty, the body, in men, acquires its most perfect symmetry.

But, in women, the body sooner attains this symmetry. As their size is smaller, and their muscles, and other parts, less strong, compact, and solid, than those of men, they arrive more early at a state of maturity. A woman at twenty years is as perfectly formed as a man at thirty.

The body of a well-shaped man ought to be square, the muscles boldly marked, and the features of the face di tinctly defined. In women, the parts are rounder and softer, and their features are more delicate. Man is adorned with strength

and majesty; grace and softness are the peculiar embellishments of woman.

Even the external figure of the human species declares them to be the sovereigns of the earth. The body of man is erect; his attitude is that of command; and his countenance, which is turned towards the heavens, is impressed with the signatures of superior dignity. The image of his soul is painted in his face; the excellence of his nature penetrates through his material form, and animates his features with a divine illumination. His majestic deportment, and the firmness of his movements, announce the superiority of his rank. He touches the earth with his extremity only: he views it at a distance, and seems to despise it. His arms are not pillars to support his body: his hands tread not the earth, and lose not, by friction and pressure, that delicacy of feeling for which they were originally destined. His arms and hands are formed for purposes more noble; namely, for executing the commands of his intellect, for laying hold of distant objects, for removing obstacles, for defending him from injuries, and for seizing and retaining objects at pleasure.

When the mind is at ease, all the features of the countenance are in a state of profound tranquillity. Their proportion, their harmony, their union, point out serenity of sentiment, and accord with the calm that subsists within. When the soul, however, is agitated, the human visage becomes a living canvas, upon which passions are represented with equal energy and delicacy;

where every emotion is expressed by a correspondent feature; where every impression anticipates the will, and reveals, by obvious and pathetic characters, those intentions and feelings which we are solicitous to conceal.

It is in the eyes that the passions are most strongly marked, and most readily discovered. The eye belongs to the soul more than any other bodily organ. It participates of every mental emotion, the softest and most tender, as well as the most violent and tumultuous. It exhibits these emotions in all their force and purity, and infuses into the soul of the spectator the fire and the agitation of that mind in which they originate. In fine, the eye reflects the light of thought, and the glow of sentiment; it is the sense of the understanding, and the language of intelligence.

Men who squint, or are short sighted, have less of this external soul (as it may be termed), whose chief residence is in the eye. These defects hurt the physiognomy, and give to the finest countenance a disagreeable, and often a stupid air. As nothing but strong and violent passions are discoverable in visages of this kind, and as they exhibit no marks of delicacy or vivacity of sentiment, we are apt to form unfavourable impressions of such persons, which, however ill-founded, it is difficult for us to efface. We are so accustomed to be influenced by external appearances, that if no symptoms of thought and reflection appear in a man's countenance, we instantly decide him to be void of ability. We

even draw conclusions from the cut of the clothes, or the curls of the periwig; neither are these conclusions always false. Men ought, therefore, to pay some attention to these minute articles; because, in the eye of strangers, they make a part of ourselves, and contribute not a little to the judgments they form of our understanding and breeding.

A vivacious or a languid motion of the eye has a prodigious effect on the character of the countenance. Eyes are of different colours, dark hazel, light hazel, green, blue, gray, and whitish gray. The iris has a smooth velvet-like appearance, and consists of many small filaments, regularly disposed, and directed towards the centre of the pupil. The most usual colours of the eye are the hazel and the blue; and both these colours are sometimes to be found in the same eye. The eyes commonly called black, when narrowly inspected, are only of a dark hazel colour. They appear black in consequence of their being contrasted with the white of the eye. Those of a less deep hazel are likewise reckoned black, but are not equally beautiful. Shades of orange, hazel, gray, and blue, are frequently to be met with in the same eye; but, wherever there is a blue tint, it becomes the prevailing colour, and outshines all the rest. The black and the blue are the most beautiful colours, and give most fire and vivacity of expression to the eye. In black eyes there is more force and impetuosity; but the blue excel in sweetness and delicacy. The former dart forth

a perpetual and uniform flame, because their colour appears always the same, and reflects the same rays: but the modifications of light are distinguishable in the blue; because different rays are reflected by the various tints of which they are composed.

These and other varieties in the colours of the eyes, are peculiar to man, the horse, &c. In most other animals, the colours of individuals vary not. The eyes of the ox are brown; those of the sheep are of a watery colour; those of the goat are gray, &c. Aristotle alleges, that, among men, gray eyes are the strongest; that the blue are weaker; that prominent eyes are short-sighted; and that brown eyes see not so well as others in a faint light.

Though the eye, in moving, seems to be drawn towards either side, yet it only moves round its own centre, which gives the pupil the appearance of approaching or receding from the angles of the orbit, and of being elevated or depressed. In man the eyes are nearer each other than in any other animal. In some species, the eyes are so remotely situated, that it is impossible for both eyes to see the same object at the same time.

Next to the eyes, the parts which give most character to the countenance are the eyebrows. Being totally different from every other feature, their effect is augmented by the contrast: they form a deep shade in the canvas, and give relief to the other colours and features. The lashes of the eyelid have also their effect; when long and

bushy, they bestow beauty on the eye, and give a mild and pleasant aspect to the face. Lashes on both eyelids are peculiar to man and the ape. Other animals have hair on the upper lid only; and even in man, the lash of the under lid is less than that of the upper. The eyebrows have only two movements; one by which they are elevated; and the other by which they are depressed and contracted.

The eyelids guard the ball of the eye from dust, insects, &c., and keep the cornea moist. The upper eyelid moves up and down; but the under lid has little or no motion. Although the motion of the eyelids be subject to the will, yet, by sleep, fatigue, or surprise, we lose the command of them. They are sometimes also affected with convulsive motions, which we are unable to restrain. In birds and amphibious quadrupeds, the under eyelid alone moves; and fishes and insects have no eyelids, either above or below.

The forehead occupies a large part of the face, and contributes greatly to its beauty. It should be well proportioned, neither too flat nor too prominent; neither too narrow nor too short; and it should be regularly adorned with hair both above and on each side. The hair gives great expression to the countenance; baldness is therefore a capital defect; and the practice of employing superficial hair, which is now so general, ought to be confined to such as are naturally bald; for borrowed locks often change the true

character of the face. If every man wore his own hair, and allowed it to float freely, it would be more easy to distinguish characters by the general aspect of the countenance. The crown of the head, and immediately above the temples, are the parts which first become bald; but the hair below the temples, and on the under part of the back of the head, seldom falls off. Baldness is peculiar to man: women, in the most advanced age, though their hair becomes white, are seldom affected with baldness: children and eunuchs are not more subject to it than women; and the hair is stronger and more abundant in youth than at any other period. The longest hair becomes dry, and gradually wastes and falls off as we advance in life. The whiteness commences at the points; and when the hair is totally white, it loses its strength, and at last falls off altogether. There have been examples of young people whose hair was rendered white by disease, and which recovered its natural colour after their health was restored. It is alleged by Aristotle, that no man becomes bald before having intercourse with women, except such as have been bald from their birth. The ancient writers upbraid the inhabitants of the islands of the Archipelago with the epithet *bald heads;* and assert, that these islanders are all brought into the world with this defect*.

* See Dapper's Voyage, p. 354, and Pliny Edit. Hardouin, p. 541.

The nose is the most prominent feature in the face. But, as it has very little motion, even in the most violent passions, it contributes more to the beauty than to the expression of the countenance; and, unless it be deformed, or greatly disproportioned, it is less attended to than those features which are capable of motion, as the mouth and the eyes. The form of the nose, and its remarkable prominency, are peculiar to the human species. Most animals have nostrils separated by a partition; but none of them have an elevated and advanced nose. Even the apes may be said to have nostrils only; the nose of an ape has the same position as that of a man; but it is so short and flat, that it can hardly be regarded as similar. By this organ, men, and most animals, breathe, and smell odoriferous bodies. Birds have no cartilaginous nostrils; they have only two holes or pipes for the purposes of respiration and smelling.

Next to the eyes, the mouth and lips have both the greatest motion and expression. These motions are excited by the passions, and the various forms of the mouth mark their different characters and modifications. The organs of speech give the mouth an animation superior to every other part of the face. The vermillion of the lips, and the whiteness of the teeth, so much excel the other colours of the face, that they attract our chief regard. We fix our eyes on the mouth of the speaker; every word, every articulation, produces different motions on the lips; and, how-

ever rapid, it is easy to distinguish them from each other. The deaf learn to distinguish these motions so accurately, that they often know the sentiments of the speaker merely by attending to the motions of his lips.

In man, and in all other animals, the under jaw is alone endowed with the power of motion. The crocodile, the opinion of Aristotle and many other naturalists notwithstanding, is not an exception: I have examined many skeletons of that animal, and have found, by the nature of the articulation, that the under jaw alone was moveable. In the human fœtus, and in monkeys, the under jaw is greatly advanced before the upper. The deformity, in adults, is equal, whether the under jaw be too prominent or too much depressed: it ought to be nearly on a level with the upper. Strong passions, as well as languor, often produce an involuntary motion in the under jaw: pain and pleasure, as well as languor, give rise to yawning; but, in the former, the motion is more brisk and lively.

When the mind is suddenly affected with ardent desire, or keen regret, we feel a sort of starting, or internal oppression; this motion of the diaphragm elevates the lungs, and produces that sudden inspiration which forms a sigh: and, when the mind considers the cause of its emotion, and perceives no method of accomplishing its desire, or of banishing its regret, the sighs are repeated, and sorrow, or mental pain, succeeds. If this pain of mind be great and unexpected, it pro-

duces tears; the air rushes quickly into the lungs, and gives rise to many inspirations, which are accompanied with involuntary shocks: each inspiration makes a noise stronger than that of sighing, and is distinguished by the name of sobbing; these sobs succeed each other more rapidly than sighs; and, in the former, the sound of the voice is more apparent. The accent of the voice is still more distinguishable in groaning, which is a species of sob long continued; and its slow sound is heard both in expiration and inspiration: its expression consists in the continuation of a plaintive tone formed by inarticulate sounds. Groans are shorter or longer according to the degree of sorrow or dejection; but they are generally repeated several times. The time of inspiration forms the interval that takes place between each groan; and the intervals are nearly equal both in their duration and their distance. The plaintive shriek is a groan expressed with force, and with a high tone of voice. The shriek, when very sharp, generally continues on the same tone through its whole extent; but when moderate, it commonly ends in a lower tone.

Laughter is an interrupted sound, often repeated, and accompanied with a kind of convulsive motion of the belly, which is alternately elevated and depressed. To facilitate this motion, the breast and head are sometimes thrown forward; the chest remains immoveable; the angles of the mouth recede from each other;

and the cheeks swell: every time that the belly is depressed, the air bursts from the mouth, and occasions a noise, which, during the fit, is often repeated, sometimes on the same tone, and sometimes the tones gradually diminish.

The lips, in immoderate laughter, and in most violent passions, open wide; but, in the more tranquil emotions, the angles of the mouth recede, without any opening of the lips, the cheeks swell, and, in some persons, dimples are formed in them near the corners of the mouth: this charm belongs to the graces, and is commonly attended with an agreeable smile, which is a mark of benevolence, and of internal satisfaction: a smile is also a mode of expressing contempt and ridicule; but, in these malignant smiles, we press the lips close to each other.

The cheeks are uniform features, and have little motion or expression, except from that involuntary redness or paleness with which they are covered in different passions; they unite the features, and give a contour to the face: they contribute more to beauty than to expression; and the same observation may be applied to the chin, the ears, and the temples.

Shame, anger, pride, joy, equally give rise to blushing; while fear, terror, and sorrow, produce a paleness in the face. This change of colour is involuntary; it exhibits the state of the mind without its consent. It is an effect of sentiment over which the will has no command. We can easily disguise the other marks of passion; for a

moment's reflection enables us to stop the action of the muscles of the face which characterize particular passions, and even to change their direction; but to stop or alter the redness or paleness of the countenance, is beyond our power; because these depend on a peculiar motion of the blood, occasioned by the action of the diaphragm, which is the chief internal organ of sensation.

In different passions, the whole head is affected with different motions and positions: it hangs forward during shame, humility, and sorrow; it inclines to one side in languor and compassion; it is elevated in pride, erect and fixed in obstinacy and self conceit; it is thrown backward in astonishment or surprise; and rolls from side to side in contempt, ridicule, and indignation.

Grief, joy, love, shame, and compassion, make the eyes swell, and cause the tears to flow. The effusion of tears is always accompanied with a contraction of the muscles of the face, which opens the mouth; the tears flow through the lachrymal ducts into the nose, and increase the fluid with which it is naturally moistened: the flowing of the tears is not constant; they seem to burst out at irregular intervals.

In grief, the corners of the mouth are depressed, the under lip rises, the eyelids fall down, the pupil is elevated, and half concealed under the eyelid: the other muscles of the

face are relaxed, which enlarges the space between the mouth and the eyes; and, of course, the countenance appears to be stretched out beyond its ordinary length. (See plate xvi. fig. 1.)

In consternation and terror, the brow is wrinkled, the eyebrows are elevated, the upper eyelid opens so wide, that it rises above the pupil, and uncovers a part of the white above the pupil, which last falls down, and is partly concealed by the under lid. The mouth, at the same time, opens wide, the lips recede from each other, and expose the teeth both above and below. (See plate xvi. fig. 2.)

In contempt and derision, one corner of the upper lip rises, and leaves the teeth bare; the other corner moves a little, and has the appearance of a malignant smile; the nostril next the elevated side of the lip shrivels up, and the angle of the mouth falls down. The eye on the same side is almost shut, while the other remains open; and both pupils are depressed in the same manner as when a person looks down from a height. (See plate xvi. fig. 3.)

In jealousy, envy, and malice, the eyebrows fall down and are wrinkled; the eyelids rise, and the pupils fall down; the upper lip is elevated on both sides; the angles of the mouth sink a little, and the middle of the under lip [illegible] and joins the middle of the upper one. (See plate xvi. fig.4.)

In laughing, the angles of the mouth are drawn back, and somewhat elevated; the upper

184A

Plate 16

part of the cheeks rises; the eyes are more or less shut; the upper lip rises and the under one sinks; the mouth opens; and, when the laughter is immoderate, the skin of the nose wrinkles. (See plate xvi. fig. 5.)

Beside these marks, the arms, the hands, and the whole body, contribute to the expression of the passions. Gesture also concurs with the action of the features in expressing the different emotions of the soul. In joy, for example, the eyes, the head, the arms, and whole body, are agitated with quick and various movements. In languor and grief, the eyes are sunk, the head reclines, the arms hang down, and the whole body remains fixed and immoveable. In admiration, surprise, and astonishment, every motion is suspended, and the person remains in the same uniform attitude. These expressions of the passions are involuntary: but there is another species of expression, which consists in an agitation of the eyes, head, arms, and body; and these motions seem, at the same time, to be the effect of reflection, and to depend on the will. They appear to be efforts of the mind to defend the body, and may be regarded as secondary symptoms, by which particular passions may be distinguished. In love, hope, and keen desire, we elevate the head, and turn towards heaven, as if imploring possession; we stretch forward the head to make a nearer approach; and we extend the arms and open the hands, in order to seize and embrace the beloved object. On the other hand,

in fear, hatred, and horror, we push the arms forward with precipitation, to repel the object of our aversion; we turn back the head and the eyes; we recoil, and at last fly, in order to avoid it. These motions are so sudden, that they appear to be involuntary; but this deception is the effect of habit; for these motions are produced by reflection, and, by their alacrity, discover the perfection of those qualities of the body which enable it to obey, with such amazing promptitude, the commands of the mind.

As the passions are agitations or movements of the mind, for the most part connected with impressions of sensation, they may be expressed by motions of the body, and particularly by those of the countenance. We can, therefore, form a judgment of the affections of the mind by the motions of the body, and can discover the real situation of the soul by examining the changes in the features of the face. But, as the mind has no figure which can have any relation to that of matter, we can form no judgment of the general disposition of any mind by the features of the countenance, or by the figure of the body with which it is connected. A deformed body may contain an amiable mind; neither should we pronounce concerning the natural disposition of any person, merely because the features of his countenance are not agreeable; for there is no analogy between features and the nature of the soul, upon which any reasonable conjectures can be founded.

The ancients, however, were much addicted to this false notion; and there have not been wanting, in every age, men who wished to support a scientific divination, derived by a pretended skill in physiognomy. But nothing is more evident, than that this species of divination can be extended no farther than to the affections of the mind, when expressed by the motion of the eyes, visage, and other parts of the body: the form of the nose, of the mouth, and of other features, has no more connexion with the natural disposition of any person, than the stature, or size of the limbs, with the faculty of thinking. Has a man more genius in proportion as his nose is well made? Is the ability of another more circumscribed, because his eyes are small and his mouth large? It must, therefore, be acknowledged, that the divination of physiognomists is altogether c[illegible]rical, and destitute of any foundation in [illegible].

The ears, of all the parts of the hea[illegible]ontribute least to the expression of the face. They are placed at a side, and commonly co[illegible]cealed under the hair. But, in quadrupeds, the ears are more apparent; and by them we can discover whether the creatures be in a state of vigour or of imbecility; their motions denote sentiment, and correspond to the internal feelings of the animal. The human ears, though furnished with muscles, have hardly any motion, either voluntary or involuntary. Small ears are said to be most beautiful; but large ones are better calculated for hearing. Some nations greatly en-

large the lobes of their ears, by piercing them, and placing in them pieces of wood or metal, which they change successively for others of greater dimensions, till the holes become enormous; and the lobes uniformly increase in proportion to the size of the holes. I have seen these round pieces of wood, which had been brought from India or South America, of more than an inch and a half in diameter. It is difficult to investigate the origin of this singular custom: but it is equally difficult to trace the origin of piercing the ears (a practice almost general), and sometimes the nostrils, in order to adorn them with rings, &c., unless we attribute it to those naked savages, who contrived to carry, in the least incommodious manner, such things as appeared to them to be most precious.

The whimsical varieties in the customs of different nations are still more apparent in the manner of dressing and wearing their beards. The Turks shave their heads, but allow their beards to grow. Most Europeans, on the contrary, shave their beards, and wear their own or borrowed hair. The savages of America pull out the hairs of their beards, but carefully preserve those of the head. The negroes shave their heads in different figures; sometimes they cut their hair in the shape of little stars, sometimes in the manner of a friar, but most commonly in alternate stripes. The Talapoins of Siam shave the heads and eyebrows of those children whose education is entrusted to them. In this article

every nation has different usages. Some prefer the hair on the upper lip to that of the chin; others esteem hair on the cheek; some curl it, and others wear it straight. It is not long since we wore our hair behind loose and floating; we now inclose it in a bag. Our dress is different from that of our fathers. The differences in dress are as various as the different nations of the globe: and, what is singular, we have adopted that dress which is most incommodious, wastes most time in adjusting, and is least agreeable to Nature.

Though fashions seem to be founded on caprice and fancy; yet, when generally adopted, they merit examination. Men have always given a value to those things which excite attention, and which convey flattering ideas of riches, power, and grandeur. The value of diamonds, and other precious stones, arises from their scarceness and brilliancy. The same observation applies to those shining metals, the weight of which we regard so little, that, for the sake of finery, we spread them over our garments. Ornaments of this kind are intended to excite the attention of spectators, to give them an idea of splendor and wealth, and to dazzle their fancies: how few have the capacity of distinguishing the person from the dress, or of estimating the man in any other manner than by the metal on his clothes!

Every thing that is rare and brilliant, will, therefore, always be fashionable, while men de-

rive more eminence from riches than virtue, and while the means of acquiring respect continue so widely different from real merit. Strangers receive their first impressions of us from our dress, which is varied according to the points of view in which we wish to be considered. The modest man, or he who wishes to assume that character, dresses with a simplicity corresponding to the nature of that virtue. The vain-glorious, on the contrary, neglect nothing that can support their pride or flatter their vanity; and they distinguish themselves by splendor or fineness in their external appearance.

Another very general object of dress is to increase the size of our figure, and to occupy more room in the world than Nature has allotted to us. We wish to enlarge our dimensions by high-heeled shoes and blown up garments; but, however bulky our dress, it is exceeded by that vanity which it endeavours to cover. Why is the doctor's head loaded with an enormous quantity of borrowed hair, while that of the beau is so thinly covered? The former wishes to have the extent of his learning measured by the apparent dimensions of his head; and the latter desires to diminish his head, that he may exhibit the gaiety and sprightliness of his genius.

Other fashions appear to have a more rational object, namely, to conceal the defects of Nature, or to render them less disagreeable. Tak-king mankind in general, there is a greater number of deformed bodies, and disagreeable faces,

than of handsome figures, and beautiful countenances. Fashions are always regulated by the practice of the majority; and, as the greatest part of mankind have defects to conceal, it is their interest to invent and support those modes which tend to render their deformities less conspicuous. Women never think of paint, till the natural bloom of their cheeks is faded. Painting, however, is a very general custom. The mode of whitening the hair * with powder, and curling it, is not so universal; but it seems to have been intended for the same purpose, to make the colours and features of the countenance appear with greater advantage.

But, leaving external ornaments, and the drapery of the picture, let us return to the figure itself. The head of man is differently constructed, both internally and externally, from that of any other animal. The head of the monkey makes the nearest approach; its brain, however, is proportionally less; and there are other differences, to be afterwards pointed out. The bodies of almost all quadrupeds are entirely covered with hair. In man, the head alone has this ornament before the age of puberty, and it is more amply furnished with hair than the head of any other animal. The monkey resembles man very much in his ears, nose, and teeth.

* The savages of New Guinea powder their heads and beards with chalk. See Receuil des Voyages, &c. tom. iv. p. 637.

Among animals, there is a great diversity in the size, position, and number of their teeth. Some are furnished with teeth in both jaws; others have them in the under jaw only; in some they are widely separated from each other; and are close and united in others. The palate of some fishes is a hard bony plate, stuck full of sharp points, which perform the office of teeth.

The mouths of most animals are armed with some solid substance, which enables them to apprehend or grind their food. The teeth of men, quadrupeds, and fishes, the beaks of birds, the pinchers, saws, &c., of insects, are all hard instruments, and, like the nails, horns, and hoofs, derive their origin from the nerves. We formerly remarked, that nerves, when exposed to the air, acquire a surprising hardness. As the mouth gives a free access to the air, it is therefore natural to think that the nerves which terminate there should harden, and produce the teeth, the bony plate, the beak, the pinchers, and all the other solid parts of animals.

The neck supports the head, and unites it to the body. It is larger and stronger in most quadrupeds than in man. Fishes, and other animals, which are not furnished with lungs similar to ours, have no neck. Birds, in general, have longer necks than other animals. Those birds which have short claws, have likewise short necks, and *vice versa*. Aristotle says, that birds of prey which have pounces are all short necked.

The human breast is proportionally larger than that of other animals; and none but man and the monkey have collar bones. The breasts of women are larger and more prominent than those of men: but their consistence and structure are nearly the same; for the breasts of men can secrete milk. There are many examples of this fact; and it commonly happens at the age of puberty. I have seen a young man of fifteen years squeeze more than a spoonful of milk out of one breast. Among animals, there is a great variety in the number and situation of their paps. Some, as the monkey and elephant, have only two placed on the fore part of the breast; others have four, as the bear; others, as the sheep, have only two, situated between the hinder legs; others have them in great numbers upon the belly, as the bitch and the sow. Birds, and all the oviparous animals, have no paps. Viviparous fishes, as the whale, the dolphin, &c., have breasts, and suckle their young. The form of the breasts varies in different animals, and even in the same animal at different ages. It is alleged, that women, whose breasts are shaped like a pear, make the best nurses, because the mouth of the child comprehends not only the nipple, but part of the breast itself.

Below the breast is the belly, in which the naval makes a conspicuous figure. In other animals it is hardly perceptible; and even the monkey has nothing in place of it but a kind of callosity.

The arms of man have little resemblance to the fore feet of quadrupeds, and still less to the wings of birds. The monkey tribe are the only animals which have arms and hands; but their structure is more rude, and their proportion less exact than those of man; his shoulders are likewise larger, and differently constructed from those of any other animal; and it is on the top of the shoulders that he can bear the heaviest burdens.

The form of the back differs not much from that of some quadrupeds; the region of the reins is indeed more muscular and strong. But the buttocks are peculiar to the human body; the thighs of quadrupeds are often mistaken for the buttocks, though they be totally different. Man being the only animal who can support himself perfectly erect, the swelling, or cushion on the top of his thighs, is necessary to sustain him in that posture.

The human foot is very different from that of all other animals, the monkey not excepted. The foot of the ape is rather a kind of hand; its toes are long, and situated like fingers, the middle one being by much the longest; and it has no heel. The sole of the foot is likewise larger in man, and his toes are better adapted for preserving the equilibrium of the body in walking, running, dancing, and other movements.

The human nails are less than those of other animals. If they protruded much beyond the points of the fingers, they would obstruct the

dexterity of the hand. Those savages who allow them to grow to an unnatural length, use them for flaying and tearing animals. But, although their nails be stronger and longer than ours, they can by no means be compared to the hoofs or the claws of other animals.

With regard to the proportions of the human body, we have no exact knowledge. The same parts have not the same proportions in any two individuals; and, even in the same person, the corresponding parts are not perfectly similar. For example, the right arm or leg have seldom the same dimensions with the left. Repeated observations alone can ascertain a standard by which we may be enabled to form a perfect idea of the natural and best proportions of the human figure. It is not by comparing men, or taking their dimensions, that we are to expect any light upon this subject: we have more to hope from the art of designing, and the efforts which have been made in imitating Nature. Taste and sentiment have exceeded the limits of mechanical operations. The square and compass are laid aside, and we trust more to the impressions made on the senses. Every possible form has been realized in bronze or in marble. We recognise the standard of Nature more by imitating her, than by her own productions; and we judge better concerning the perfection of a statue by viewing it, than by taking its different dimensions. It is by long practice in the art of designing, and by deli-

cacy of sentiment, that eminent statuaries have been enabled to make men feel the justness of proportion in the works of Nature. The ancients made statues so exquisitely fine, that they have uniformly been regarded as exact representations of the most perfect human figures. These statues, which were only copies of the human form, are now considered as originals; because they were not imitated from an individual, but from the whole species, so attentively compared and diligently observed, that it is impossible to find an equal degree of symmetry and proportion in any one man that ever existed. We shall, therefore, relate the dimensions of the different parts which these artists have fixed as standards of perfection. They commonly divide the height of the body into ten times the length of the face; they likewise divide each *face*, or tenth of the body, into three equal parts; the first commences at the springing of the hair on the forehead, and terminates at the root of the nose; the nose is the second division; and the third extends from the nose to the end of the chin. In measuring the rest of the body, they use the term *nose*, or length of the nose, to denote the third of a face, or the thirtieth part of the body. The first face begins at the root of the hair above the forehead, and extends to the end of the chin; but, from the top of the forehead to the crown, there is still a third of a face, or a nose, in height. Thus, from the top of the head to the end of the chin,

there is a face and a third; from the chin to the juncture of the clavicles, two thirds of a face; and, therefore, from the top of the breast to the crown of the head, is twice the length of the face, or the fifth of the body; from the joining of the clavicles to the under part of the paps, they reckon one face; from this to the navel is a fourth face; and the fifth extends from the navel to the division of the inferior extremities, which should complete half the length of the body. Two faces are exhausted between the thigh and knee, to the last of which they allow half a face, being the first half of the eighth face; two faces are assigned between the knee and top of the foot, and from that to the sole half a face, which completes the ten faces, or length of the body. This division has been made from men of ordinary size; but in those of a higher stature, they allow about half a face additional between the paps and the commencement of the thighs, which, in tall men, is not the middle of the body. When the arms are fully stretched in a horizontal line, the space between the tops of the middle fingers is equal to the length of the body. From the joining of the collar bone to the articulation of the shoulder bone with that of the arm, is one face. When the arm hangs down, or is bended forward, it is four faces in length; two between the joint of the shoulder and the elbow, and two between the elbow and the root of the little finger, in all five faces, and an equal number for the other arm, which is precisely the length of the

body; about half a face remains for the length of the fingers; but it must be remarked, that half a face is lost in the joints of the elbows and shoulders, when the arms are extended. The hand is about a face in length, the thumb a third of a face, or a nose, and the longest toe is of the same length with the thumb. The under part of the foot is equal in length to the sixth part of the height of the body. For the reasons already mentioned, if an experiment be made of these dimensions upon any individual, they will appear to be extremely imperfect. It is still more difficult to fix the proportional thickness of the different parts of the body. The changes are so great when the same man is meagre or in good case, and the action of the muscles, in different positions, creates so much variety in the dimensions of the parts, that it is almost impossible to give any determined rules upon this subject.

The superior parts of the body, in infancy, are larger than the inferior; the thighs and legs are not nearly equal to half the length of the whole body; as the child advances in years, the inferior parts grow more in proportion than the superior; and, when the growth is complete, the thighs and legs are very nearly one half the length of the body.

The anterior part of the chest, in women, is more elevated, and its diameter larger than in men; but the chests of the latter are proportionally broader. The haunches of women are

likewise larger than those of men; because the haunch bones of women, and those which join them and compose the pelvis, are proportionally larger. These differences in the structure of the chest and pelvis are so perceptible, that it is easy, by this criterion, to distinguish the skeleton of a woman from that of a man.

There are great varieties in the length of men. Those are said to be tall who are from five feet eight inches to six feet high. The middle stature is from five feet five to five feet eight; and those who fall below these dimensions are said to be of small stature. Women, in general, are two or three inches below the standard of men. Of giants and dwarfs, notice shall be taken in another place.

Though the human body be externally more delicate, it is, however very nervous, and perhaps stronger, for its size, than the most robust quadruped. In comparing the force of a lion to that of a man, it ought to be considered, that the lion is armed with teeth and talons; and that these dreadful weapons convey a false idea of real strength. The arms which man has received from Nature are not offensive; and happy had it been if art had never put into his hands weapons more destructive than the claws of the lion.

But there is a juster method of instituting a comparison between the strength of a man and that of the other animals, namely, by the weight they are able to carry. It is affirmed, that the

porters of Constantinople can carry burdens of 900 pounds weight; and Desaguliers tells us, that, by means of a certain harness, by which every part of a man's body was proportionably loaded, the person he employed in this experiment was able to support, in an erect posture, a weight not less than 2,000 pounds. A horse, which is about six times the size of an ordinary man, ought, therefore, when managed in the same manner, to bear 12,000 or 14,000 pounds; an enormous weight, in comparison of what that animal can support, even when it is distributed with every possible advantage.

The strength of animals may likewise be estimated by agility and perseverance in labour. Men, when accustomed to running, outstrip horses, or at least continue their speed much longer; and a man will accomplish a long journey sooner, and be less fatigued, than even the best road horses. The royal messengers of Ispahan, who are trained to running, go thirty-six leagues in fourteen or fifteen hours. We are assured by travellers, that the Hottentots outrun lions in the chace; and that those savages who live upon hunting, pursue and even catch deer, and other animals of equal swiftness. Many other stories are told of the amazing nimbleness of savages, of the long journeys they accomplish on foot, over the most craggy mountains, where there is no path to direct, and every obstacle to obstruct their progress. These people are said to travel 1,000 leagues in six weeks, or at

most two months. If we except birds, whose muscles are proportionally stronger than those of any other animal, no other creature could support such long continued fatigue. The civilized man is ignorant of his own strength; nor is he sensible how much he is weakened by effeminacy, nor to what extent he might recover his native force by an habitual and vigorous exercise of his powers.

Men of extraordinary strength sometimes appear*. But this gift of Nature, which would be highly valuable in the savage state, is of little use among polished nations, where more depends on mental than corporeal powers, and where manual labour is confined to the inferior orders of men.

Men are much stronger than women; and they have often employed this superiority in exercising a cruel and tyrannical dominion over the weaker sex, who were entitled to share with them both the pleasures and the pains of life. Savage nations condemn the women to perpetual labour. They cultivate the ground, and perform every office of drudgery, while the men indolently recline in their hammocks, from which they never think of stirring, unless when they go a hunting or fishing; and, so averse are they to motion, that they have often been known to stand in the same position for several hours.

* Nos quoque vidimus Athanatum nomine prodigiosæ ostentationis quingenario thorace plumbeo indutum, cothurnisque quingentorum pondo calcatum, per scenam ingredi. Plin. lib. 7.

A savage has no idea of walking for amusement; and nothing astonishes him more than to see Europeans walking backwards and forwards in quest of nothing. All men are naturally indolent; but the savages of warm countries are not only the most lazy of human beings, but the most tyrannical to their women, whom they treat with a cruel barbarity. In nations more civilized, men dictate laws to the women. These laws are always more severe in proportion to the grossness of the national manners; and it is only among people highly polished that women have obtained that equality of condition which is due to them, and which contributes so powerfully to the happiness of society. This politeness of manners is the genuine offspring of the softer sex; they have opposed it to the arms of the victor, while their modesty has taught us to acknowledge the empire of beauty, a natural advantage greatly superior to mere strength. But to give it full force and value, requires the assistance of art; for the ideas of beauty are so different, so capricious, and even contradictory, that the women, it is probable, have gained more by the art of making themselves amiable, than by beauty itself, of which men form such opposite judgments. Men are agreed as to the ultimate object of their passion for the other sex, the estimation of which is augmented by the difficulty of acquisition. The beauty of women commenced the moment they learned to make themselves respectable, by refusing all approaches to their hearts which proceeded not from delicacy

of sentiment; and, whenever the influence of sentiment was felt, polished manners was a necessary consequence.

The taste of beauty, among the ancients, differed widely from ours. With them, a small forehead and joined eyebrows were charming features in a female countenance; and, in Persia, large joined eyebrows are still highly esteemed. In some Indian countries, black teeth and white hair are necessary ingredients in the character of a beauty; and in the Marian islands it is a capital object with ladies to blacken their teeth with herbs, and to bleach their hair with certain liquors. Beauty, in China and Japan, is composed of a large countenance, small and half concealed eyes, a broad nose, minute feet, and a prominent belly. Some Indians of America and of Asia compress the heads of their children between two wooden planks, with a view to enlarge and beautify the face; others compress them laterally, others depress the crown only, and others make the head as round as possible. Every nation has ideas of beauty peculiar to itself; and every individual has his own notions and taste concerning that quality. These peculiarities probably originate from the first agreeable impressions we receive of certain objects; and therefore depend more upon chance and habit than upon difference of constitution. When we come to treat of the senses, we shall perhaps be able to give more determined ideas concerning those perceptions of beauty we receive by the eye.

SECT. V.

Of Old Age and Death.

EVERY object in Nature must change and decay. The bodies of men no sooner arrive at full maturity, than they instantly begin to decline. The waste is at first insensible; several years frequently revolve before we perceive any considerable alteration. But we ought to feel the weight of our years, better than their number can be estimated by strangers; and, as those are seldom deceived who judge of our age by external characters, we would be still more sensible of it from what passes within us, if we were more attentive to our feelings, and deceived not ourselves by vanity and fallacious hopes.

When the body has acquired its full length, it increases in thickness: the commencement of this augmentation is the first step towards decay; for this extension is not a continuation of growth, which would communicate force and activity, but merely an addition of superfluous matter, that blows up the body, and loads it with a useless weight. This matter, which is denominated fat, generally appears at the age of thirty-five or forty years; and, in proportion as the quantity of it augments, the body loses its for-

mer lightness and freedom of motion; its generative faculty is diminished; its members turn unwieldy; and it acquires extension at the expense of strength and activity.

Besides, the bones increase in solidity; the nutritious juices, which formerly served to expand the bones, now increase their quantity of matter only, by filling up their internal cavities; the membranes are changed into cartilages, and the cartilages into bones; the fibres of the muscles grow rigid; the skin is deprived of its moisture, and wrinkles are gradually formed in it; the hair turns hoary; the teeth fall out; the visage assumes a haggard appearance, the body bends forward, &c. The first approaches of this state are perceptible before the age of forty; they advance by slow degrees till sixty, and more rapidly from that to seventy, when decrepitude commences, and continues to augment till ninety or 100, when death puts a final period to our existence.

We shall now take a more particular survey of these changes; and, as we have inquired into the causes of the growth and expansion of the human body, let us also investigate those of its decay and dissolution. At the commencement of our existence, the bones are only small fibres, of a soft and ductile substance, and gradually acquire consistence and solidity. They may be considered, in their original state, as small tubes, lined both within and without with a thin membrane: this double membrane furnishes the osseous matter; for the small interval between the internal and externa

periosteum is soon converted into a bony plate. Some idea of the production and growth of bones may be formed, by comparing them with the manner in which wood and the more solid parts of vegetables are produced. We shall take, for example, the fig tree or the alder, which are at first hollow in the middle, like the thigh and other hollow bones of the body. When a bud, that is to form a branch, begins to extend, it is only a soft ductile matter, which, by extension, becomes a slender herbaceous tube, filled with pith. The external and internal surfaces of this tube are covered with a fibrous membrane, as well as the internal partitions by which the cavity is divided. These membranes, however thin, are composed of several plates of fibres lying above each other, which are still soft, but gradually harden by depositing the sap which they absorb for their nourishment; and by this means a woody plate is formed, during the first year, between the two membranes, which is more or less thick, in proportion to the quantity of sap that has been deposited between the external and internal membranes. But, though each of these membranes become woody internally, their external surfaces remain soft and ductile; and, the following year, when the bud at the top of the branch begins to expand, the sap rises through the soft fibres of each membrane, and converts them, by its sediments, into other woody plates. The same process goes on annually; and, in this manner, the tree or branch gradually increases in

thickness. The internal cavity likewise augments in proportion to the growth of the branch; because the internal membrane extends along with the other parts, and the woody plates are only applied successively to the plates already formed. If we examine a branch, or a joint, which has been the product of one year, we shall find, that it uniformly preserves the same figure through all the stages of its growth. The joints or knots which mark the production of each year, become fixed points for the reaction of those powers that expand the contiguous parts during the following year. The superior buds react against these points, and, by expanding themselves, form new branches or joints in the same manner as the first were produced.

The process of ossification would be very similar to that we have now described, if the fixed points of the bones began at the extremities, in place of the middle. At first, the bones of the fœtus are only small threads, or tubes, of a ductile matter, which are easily perceived through the delicate and transparent skin. The thigh bone, for example, is then a small, short tube, like the herbaceous tubes above described. This tube is shut at both ends by a pulpy substance, and its external and internal surfaces are covered with two membranes composed of several layers of soft and ductile fibres. In proportion as this tube receives nutritious juices, the two extremities extend and recede from the middle point, which always preserves the same station.

The extremities cannot extend without reacting against this middle point; and the parts which are nearest it begin first to acquire solidity. The first bony plate, like the first plate of wood, is produced in the interval which separates the two membranes or periostea. But the ossification commences in the middle, and gradually extends to the extremities, which remain soft long after the middle parts are converted into bone. The middle parts of bones, therefore, being first ossified, it is impossible that they should afterwards expand equally with those parts which remain longer in a soft and ductile state. This is the reason why bones are always thinnest in the middle, and thickest at the extremities. But, independent of this difference between the longitudinal growth of bones and of wood, the analogy between their increase in thickness is very striking: for the first bony plate is produced from the internal part of the periosteum; and, after the formation of this plate between the two periostea, two other plates are soon formed, one on each side of the first, to which they adhere; and by this means both the circumference of the bone, and the diameter of its cavity, are augmented. Thus the interior parts of the two periostea continue successively to produce bony plates, in the same manner as woody plates are produced from the bark of vegetables.

But, after the bone has acquired its full growth, after the periostea cease to furnish osseous

matter, then the nutritious juices, which were formerly employed in augmenting the bulk of the bone, serve only to increase its density. These juices are deposited in the internal parts of the bones, and give them more weight and solidity, as may easily be perceived by comparing the weight and density of the bones of an ox with those of a calf. The substance of the bones becomes, in process of time, so compact, as not to admit the circulation of those juices which are necessary for their support and nourishment. This substance, therefore, must now undergo a change similar to that which takes place in old trees, after they have acquired their full solidity; and this change is one of the first causes which render the dissolution of the human body inevitable.

The cartilages, which may be regarded as soft and imperfect bones, likewise receive nutritious juices, which gradually augment their density. They become more and more solid as we advance in years; and, in old age, are almost as hard as bones. This rigidity of the cartilages renders the motion of the joints extremely difficult, and, at last, deprives us of the use of our members, and produces a total cessation of external movements. This is a second, and more marked cause of death, because it manifests itself by a laborious performance of the common actions of the body.

The membranes likewise become hard and dry, as we advance in years. Those, for example, which surround the bones, soon lose their flexibility. At the age of twenty, they are inca-

pable of farther extension. The muscular fibres suffer a similar change, in proportion to the time of life; though, to the touch, they seem to be softer as age increases. It is not the muscles, however, but the skin, that occasions this perception. After the body is come to its full growth, the fat increases, and, by being interposed between the fibres of the muscles, and between the skin and the muscles themselves, makes them feel softer, when, in reality, their density is greatly increased. Of this fact we have an incontestible proof, by comparing the flesh of young with that of old animals. In the former, it is tender and delicate; but in the latter, it is dry, hard, and unfit for eating.

The skin always extends as the body increases; but, when the body diminishes, the skin has not elasticity enough to enable it to contract to its former dimensions: it therefore continues in wrinkles and folds, which can never be effaced. The wrinkles of the face partly arise from this cause; but, in their production, they have a relation to the form, to the features, and to the habitual motions of the countenance. If we examine the face of a man of twenty-five or thirty years of age, we may trace the origin of all the wrinkles which will appear in old age, especially when he laughs, cries, or makes any violent grimace. All the folds which are exhibited in these actions will in time become indelible wrinkles.

In proportion as we advance in years, the bones, the cartilages, the membranes, the flesh, the skin, and every fibre of the body, become

more solid, hard, and dry. Every part shrinks and contracts; and every movement is performed with slowness and difficulty: the circulation of the fluids is sluggish and interrupted; perspiration is diminished; the secretions change; digestion becomes slow and laborious; the nutritious juices are less abundant, and, being rejected by parts which are already too dense, they communicate no supplies. These parts, therefore, may be regarded as already dead, because they have ceased to receive nourishment. Thus the body dies by inches; its motions gradually decay; life wears away by imperceptible degrees; and death is only the last term in the series.

As, in women, the bones, the cartilages, the muscles, and every other part of the body, are softer and less solid than those of men, they must require more time in hardening to that degree which occasions death: women, of course, ought to live longer than men. This reasoning is confirmed by experience; for, by consulting the bills of mortality, it appears, that after women have passed a certain age, they live much longer than men who have arrived at the same age.

From what has been said, it may also be concluded, that men who have a weakly appearance, and approach nearer to the constitution of women, should live longer than those who are more robust; and likewise, that persons of either sex, who are long before they arrive at their full growth, should outlive those who advance more

rapidly to that point; because, in this case, the bones, cartilages, and fibres, are later in arriving at that degree of solidity which is necessary to their destruction.

This natural cause of death is common to all animals, and even to vegetables. An oak perishes only because the older parts of the wood, which are in the centre, become so hard and compact, that they can receive no farther nourishment. The moisture they contain being deprived of circulation, and not being replaced by fresh supplies, ferments, corrupts, and gradually reduces the fibres of the wood into powder.

The duration of life may, in some measure, be computed by the time occupied in growth. A plant or an animal that acquires maturity in a short time, perishes much sooner than those which are longer in arriving at that period. In animals, as well as vegetables, the longitudinal growth is first finished. Man grows in stature till he be sixteen or eighteen years of age; but his body is not completely unfolded in thickness before that of thirty. Dogs acquire their full length in less than one year; but their growth in thickness is not finished till the second year. A man, who grows thirty years, lives till 90 or 100; and a dog, whose growth terminates in two or three years, lives only ten or twelve. The same observation may be applied to most animals. Fishes continue to grow for a great number of years; they accordingly live for centuries; because their bones never acquire the density of those of other animals. When we give

the particular history of animals, we shall examine whether there be any exception to this rule, which Nature seems to follow in proportioning the duration of life to the time of growth, and whether crows and stags live so long as is commonly imagined. But it may be laid down as a general fact, that large animals live much longer than small animals, because they require more time to finish their growth.

Thus the causes of our dissolution are inevitable; and it is equally impossible to retard that fatal period, as to change the established laws of Nature. The ideas of those visionaries, who conceived the possibility of perpetuating human life by the use of certain medicines, would have perished with themselves, if self love did not always induce us to believe what exceeds the powers of Nature, and to be sceptical with regard to the most certain and invariable truths. The universal panacea, the transfusion of the blood, and other methods which have been proposed to render our bodies immortal, are as chimerical as the fountain of youth is fabulous.

When the constitution is sound, life may, perhaps, be prolonged for a few years, by moderating the passions, and by temperance. But even this is a difficult point; for, if it be necessary that the body should exert its whole force, and that it should waste all its powers by labour and exercise, what advantages can we derive from regimen and abstinence? Some men have indeed exceeded the ordinary term of human life; without mentioning those extraordinary

instances of longevity recorded in the Philosophical Transactions, such as that of Par, who lived to the age of 144, and of Jerkins, who lived 165 years, we have many examples of the prolongation of life to 110, and even 120. These men, however, used no peculiar arts for the preservation of their bodies. They appear, on the contrary, to have been peasants, huntsmen, labourers, and people accustomed to abuse their bodies, if it be possible to abuse them by any other means than those of continual idleness and debauchery.

Besides, the varieties of climate, and of the modes of living, make no difference as to the period of our existence, which is the same in the European, the Negro, the Chinese, the American, the civilized man and the savage, the rich and the poor, the citizen and the peasant. Neither does the difference of races, of food, or of accommodation, make any change on the duration of life. Men who feed upon raw flesh or dried fish, on sago or rice, on cassada or roots, live as long as those who are nourished with bread and prepared victuals. It is apparent, therefore, that the duration of life has no dependence either on manners or customs, or the qualities of particular food; if luxury and intemperance be excepted, nothing can alter those laws of mechanism which regulate the number of our years.

Any little differences which may be remarked in the term of human life seem to be owing to the quality of the air. There are generally more

old men in high than in low countries. The mountains of Scotland, of Wales, of Auvergne, and of Switzerland, have furnished more examples of extreme old age than the plains of Holland, Flanders, Germany, or Poland. But, taking mankind in general, there is hardly any difference in the duration of life. When men are not cut off by accidental diseases, they every where live 90 or 100 years. Our ancestors never exceeded this period; and, since the age of David, it has suffered no variation. If it should be asked, why the first races of men lived 900, 930, and even 969 years? we may, perhaps, be able to give a satisfactory answer. The productions of the earth were then of a different nature. The surface of the globe, as we remarked when treating of the Theory of the Earth, was, in the first ages of the world, less solid and compact; because gravity having acted for a short time only, terrestrial bodies had not acquired their present density and consistence. The produce of the earth, therefore, must have been analogous to its condition. The surface being more loose and moist, its productions would, of course, be more ductile and capable of extension: their growth, therefore, and even that of the human body, would require a longer time of being completed. The softness and ductility of the bones, muscles, &c., would probably remain for a longer period, because every species of food was more soft and succulent. Hence, the full expansion of the human body, or when it was capable of generating,

must have required 120 or 130 years; and the duration of life would be in proportion to the time of growth, as is uniformly the case at present: for if we suppose the age of puberty, among the first races of men, to have been 130 years, as they now arrive at that age in fourteen years, the age of the Antedeluvians will be in exact proportion to that of the present race; since, by multiplying these two numbers by seven, for example, the age of the present race will be ninety, and that of the Antedeluvians will be 910. The period of man's existence, therefore, may have gradually diminished in proportion as the surface of the earth acquired more solidity by the constant action of gravity; and it is probable, that the period from the creation to the days of David was sufficient to give the earth all the density it was capable of receiving from the influence of gravitation; and, consequently, that the surface of the earth has ever since remained in the same state, and that the terms of growth, in the productions of the earth, as well as in the duration of life, have been invariably fixed from that period.

Independent of accidental diseases, which are more frequent and dangerous in the latter periods of life, old men are subject to natural infirmities, that originate solely from the decay of the different parts of the body. The muscles lose their tone, the head shakes, the hands tremble, the legs totter, the sensibility of the nerves decreases, and every sense is blunted. But the in-

capacity for generating is the most characteristic infirmity of old age. This impotency may be ascribed to two causes; an alteration in the seminal fluid, and a want of tension in the external organs. The defect of tension is easily explained from the conformation of the organ itself, which is a spongy, cavernous substance, fitted to receive into its cavities a great quantity of blood, in order both to increase its size, and to render it more rigid. In youth this organ is soft and flexible; and of course it is easily extended by the impulse of the blood. But as we advance in years, like every other part of the body, it becomes more solid, and loses its flexibility. Hence, though the impulse of the blood were equal to what it was in youth, this impulse is unable to dilate an organ which has become too dense to admit blood in a quantity sufficient to produce an erection that will answer the purposes of generation.

With regard to the change, or rather sterility of the seminal fluid, it cannot be prolific unless when it contains organic particles transmitted from every part of the body; for we have already shown*, that the production of a small organized being, similar to its parent, cannot be effected without the union of the organic particles sent from all parts of the body. But, in very aged men, the parts have become too solid, and can neither receive, assimilate, nor transmit the nutritive and prolific particles. The bones and other solids, therefore, can neither produce

* See above, chap. ii. iii. &c.

nor transmit organic particles correspondent to their own natures; these particles must, of course, be wanting in the seminal fluids of old men; and this defect is sufficient to render them incapable of generating.

But, admitting the sterility of old men to be owing to a defect in the organic particles of their seminal fluids, this defect may still be supplied by a young woman *, which not unfrequently happens; for old men sometimes, though rarely, generate; and, when they do produce, they have a much smaller share in their children than young men. This is likewise one reason why young women, who are married to old, decrepit, and deformed men, often produce monsters, or children still more deformed than their fathers. But this is not a proper place for such discussions.

The greatest part of mankind die of the scurvy, the dropsy, or other diseases which seem to proceed from a vitiation of the blood and other fluids. Whatever influence the fluids may have in the animal economy, they are only passive and divisible substances, and obey the impulses of the solids, which are the true organic active parts, and upon which the motion, the quality, and even the quantity of the fluids entirely depend. In old age, the cavities of the vessels contract, the muscles lose their tone, the secretory organs are obstructed; the blood, the lymph, and the other fluids, of course, grow viscid, extravasate,

* See above, chap. x.

and produce all those diseases and symptoms which are usually ascribed to a vitiation of the humours. But the natural decay of the solids is the original cause of these maladies. Though it be true, that the bad state of the fluids proceeds from a depravity in the organization of the solids; yet the effects resulting from a change in the fluids produce the most alarming symptoms, if they become stagnant, or if they be obstructed in their circulation by the contraction of the vessels; if, by the relaxation of the vessels, they extravasate, they must soon corrupt, and corrode the weaker parts of the solids. In this manner the causes of destruction perpetually multiply; our internal enemies grow more and more powerful, and at last put a period to our existence.

All the causes of decay which I have mentioned, act continually upon the human body, and gradually lead to its dissolution. Death, which appears so terrible to us, is the last term only in the series of evils. Life begins to decay long before it is entirely extinguished; and the changes are perhaps greater from youth till the beginning of our decay, than from decrepitude to death; for we ought here to consider life as a subject capable of augmentation and of diminution. When the fœtus is first formed, the quantity of life is almost equal to nothing: it gradually extends and acquires consistence and force, in proportion to the growth and expansion of the body. On the other hand, when the body begins to decay, the quantity of life diminishes,

till its final extinction. Thus life both commences and terminates by imperceptible degrees.

Why then should we be afraid of death, if we have no reasonable apprehensions of its consequences? Why dread this single moment, which has been preceded by an affinity of others of the same order; since death is fully as natural as life, and both arrive in the same manner, without our being being able to perceive their approach? if we inquire of physicians, and those who are accustomed to observe the actions and sentiments of the dying, we shall find, that, except in a few acute diseases, attended with agitations and convulsions, which exhibit only the appearances of pain, most men expire quietly, and without the smallest indication of uneasiness. Even when patients seem to be afflicted with the most dreadful agonies, they have no existence but in the imagination of the spectator: the truth of this has been repeatedly attested by many people who have recovered after the most violent commotions and convulsions, who, notwithstanding, were unable to recollect a single pang they had felt, or a single idea or sentiment that had passed during this seemingly distressful situation.

The greatest part of mankind, therefore, die without being sensible of the fatal stroke; and of those who preserve their senses to the last groan, there is not, perhaps, one who does not entertain some hope of recovery. Nature, for the happiness of man, has rendered this principle

much stronger than reason. Men never cease to flatter themselves with hopes of recovery, even though they might judge of their real condition from the example of others who had been afflicted with the same incurable disorders, from the tears of their friends, and from the countenances or desertion of their physicians. All these mortifying circumstances are only regarded as premature and ill-grounded fears; and hope never leaves us, till death closes the scene.

A sick man tells you, that he feels the hand of death, that the king of terrors is just about to arrive, and that recovery is impossible: but if, from zeal or indiscretion, he is informed of his approaching dissolution, his countenance instantly changes, and he betrays all that uneasiness which naturally attends the first intimation of death. This man, it is evident, gives no credit to his own assertions. He may entertain some doubts concerning his situation; but his hopes are always superior to his fears: and, if he were not alarmed by that cruel parade of grief, which too often imbitters the sick man's couch, he would never perceive the approach of his dissolution.

Death, therefore, is not that horrible object which we have fancied to ourselves. It is a spectre which terrifies us at a distance, but disappears when we approach it more closely. Our conceptions of it are founded on prejudice; and we regard it not only as the greatest of all misfortunes, but as accompanied with the most excruciating tortures. The pain, it is said, must

be extreme, when the soul separates from the body; its duration may also be long, since time is measured by the celerity of ideas; and one painful moment, by augmenting the rapidity of our ideas, may have the appearance of an age, when the train of ideas proceeds with their usual gentleness and tranquillity. This reasoning is such an abuse of philosophy, that, if it had no influence in increasing the miseries of human life, it merits nothing but silence and contempt. As such arguments, however, gain credit with weak minds, and render the aspect of death a thousand times more hideous than it really is, a refutation of them may be attended with utility.

When the soul is first united to the body, do we feel a joy that transports us? No. This union is effected without our perception; why, then, should we be conscious of their dissolution? What reason have we to believe that the separation of the soul and body is attended with extreme pain? What cause should produce this pain? Does it reside in the soul or in the body? Pain of mind can only result from thought; and pain of body is always proportioned to its strength or weakness. At the approach of natural death, the body is in its weakest state, and, of course, it can feel but very little, if any pain.

Let us now suppose a violent death: can the sufferings of a man, for example, whose head is carried off by a cannon ball, be more than instantaneous? Can the succession of his ideas, during this instant, be so rapid as to make the

pain seem to continue for an hour, a day, or a century? We shall endeavour to discuss this point.

I acknowledge that the succession of our ideas is the only natural measure of time, and that we conceive it to be shorter or longer in proportion to the uniformity or irregularity of their motions. But, in this measure, there is a unit or fixed point, which is neither arbitrary nor indefinite, but is determined by Nature, and corresponds with the particular organization of individuals. Two ideas, which succeed each other, must necessarily be separated by an interval; one thought, however rapid, must require some portion of time before it can be followed by another. No succession can take place in an indivisible instant. The same remark is applicable to sentiment or feeling. A certain time must elapse in the transition from pain to pleasure, or from one painful sensation to another. This interval between our thoughts and sensations is the unit or fixed point formerly mentioned; and it can neither be extremely long nor extremely short, but must be nearly equal in its duration; because it depends on the nature of the mind and the organization of the body, the movements of which must have a determined degree of celerity. In the same individual, therefore, there can be no succession of ideas so rapid, or so slow, as to produce that enormous difference in duration, by which a momentary pain is prolonged to that of an hour, a day, or a century.

A very acute pain, if continued for a certain time, uniformly brings on either fainting or death. Our organs, which are endowed only with a certain degree of force, cannot resist more than a certain quantity of pain. If the pain becomes excessive, the organs are unable to support it; and, of course, they can transmit no intelligence of it to the mind, with which there is no correspondence but by the distinct action of these organs. In this case, the action of the organs is interrupted; and, consequently, all internal sensation is at an end.

What I have already remarked is perhaps more than is sufficient to evince, that the instant of death is neither accompanied with extreme nor long-continued pain. But, in order to eradicate the fears of the most timid of mankind, we shall still add a few words upon this subject. Excessive pain extinguishes all reflection, though symptoms of it have sometimes appeared in the very moment of violent death. When Charles XII. received the blow which terminated, in an instant, both his enterprises and his existence, he clapped his hand upon his sword. This mortal pang, since it excluded not reflection, could not be excessive. He found himself attacked; he considered that he ought to defend himself; it is evident, therefore, that he felt no greater pain than he would have suffered from an ordinary stroke. This action could not be the result of a mechanical impulse; for I have shown, in the description of man, that the most precipi-

tate movements of the passions depend upon reflection, and are nothing but habitual exertions of the mind.

I would not have dwelt so long upon this subject, if I had not been anxious to eradicate a prejudice so repugnant to the happiness of man. I have seen many victims sacrificed to this prejudice, especially among the female sex, who die daily through the terror of death. Such dreadful apprehensions seem peculiarly to affect those who, by nature or education, are endowed with superior sensibility; for the vulgar look forward to their dissolution, either with indifference, or, at least, without any degree of terror.

True philosophy views objects as they exist. Our internal feelings would uniformly accord with this philosophy if they were not perverted by the illusions of imagination, and by the unfortunate habit of creating hypothetical phantoms of excessive pains, and of pleasures which exceed the limits of human nature. Objects are only terrible or ravishing at a distance; when we have the resolution or the wisdom to take a near inspection of them, every alarming and every alluring circumstance instantly disappear.

If this doctrine, concerning the gradual and generally insensible decay of the vital powers, required any farther support, no inconsiderable aid might be derived to it from the uncertainty of the signs of death. If we consult the writers on this subject, and particularly those of Winslow and Bruhier, we shall receive full conviction, that between life and death, the shade is often so un-

distinguishable, as to elude all the powers of the medical art. They inform us, "That the colour of the face, the heat of the body, the suppleness of the joints, are uncertain marks of life; and that the paleness of the countenance, the coldness of the body, the rigidity of the extremities, the cessation of motion, and the abolition of the senses, are very equivocal signs of death." The same remark may be made with regard to the apparent cessation of the pulse, and of respiration: these motions are often so slow, that they elude all our perceptions. A mirror or a candle is applied near the mouth of a sick man; if the mirror be sullied, or the flame vibrates, life is concluded not to be extinguished. But these effects are often produced after death has actually taken place; and sometimes they appear not, though the patient be still alive. When we wish to be certain of the death of any person, we apply fumes of tobacco, and other irritating bodies, to the nostrils; we endeavour to excite the organs by violent agitations, by pricking or scarifying the hands and feet, by applying red hot iron or wax to different parts of the body, by raising loud and unusual cries, &c. But instances have occurred where all these and similar trials have proved abortive; and yet, to the astonishment of the spectators, the person supposed to be dead has afterwards recovered the powers of life.

Hence nothing can be more apparent, than that a certain condition of life has a great resemblance to actual death. Both humanity

and reason, therefore, require that we should be cautious of abandoning the body, and of committing it too hastily to the grave. Neither ten, twenty, nor twenty-four hours are sufficient to distinguish a real from an apparent death; since instances are not wanting of persons returning from the tomb at the end of two and of three days. Why should we precipitate the interment of those persons, the prolongation of whose lives we most ardently desire? Why should a practice subsist, in the abolition of which all men are equally interested? Are not the frequent abuses recorded by physicians sufficient to deter us from too hasty interments? Mr. Winslow* informs us, "That the body, though living, is sometimes so completely deprived of every vital function, that it has every external appearance of death. But," he remarks, "both religion and charity require, that a reasonable time should be allowed to discover whether any signs of life may not still manifest themselves, otherwise we become actual murderers, by burying people who are not dead. If we may credit the greatest number of authors, three days or seventy-two hours are sufficient for this purpose. If, during this period, no signs of life appear, but, on the contrary, the body begins to emit a cadaverous odour, which is an infallible mark of death, we may then bury it without scruple."

We shall afterwards have an opportunity of

* See Winslow's Dissert. sur l'Incertitude des Signes de la Mort, p. 84.

mentioning the customs of different nations with regard to funerals, embalming, &c. The greatest part, even of the most savage people, pay more attention than we to their departed friends: what we esteem a ceremony only, they regard as a primary duty: they respect their dead; they clothe them; they speak to them; they recite their exploits; they praise their virtues: but we, who pretend to superior sensibility, fly from our dead, and inhumanly abandon them; we desire not to see them; we have neither the courage nor the inclination to speak of them; we even avoid such objects or situations as might recal the idea of them: we are, therefore, either more indifferent, or weaker, than savages.

Having thus traced the history of life and death with regard to the individual, let us now consider both in relation to the whole species. Man dies at every age; and, though the duration of his life be longer than that of most animals, yet it is unquestionably more various and uncertain. Attempts have lately been made to ascertain these uncertainties, and, by observations, to fix some standard with regard to the mortality of mankind at different periods of life. If these observations were sufficiently numerous and exact, they would be of great utility in determining the number of people, their increase, the consumption of provisions, &c. Many authors have written with ability on this subject. M. de Parcieux, of the Academy of Sciences, has lately published an excellent work for regulating

tontines and annuities. But, as his principal object was to calculate the mortality of annuitants, and as such persons are particularly pitched upon for their apparent strength of constitution, his calculations cannot be applied to mankind in general. For the same reason, his curious tables of the mortality of the different orders of religious must be confined to their proper objects. Hally, Grant, Kersboom, Simpson, &c., have also given tables of the mortality of the human species. But, as their observations have been limited to the bills of mortality in a few parishes of London, Breslau, and other large towns, they can afford little information as to the general mortality of mankind. To make complete tables of this kind, it is necessary to scrutinize the parish registers, not only of London, Paris, &c., where there is a perpetual ingress of strangers and egress of natives, but likewise those of the country, that, by comparing the results of both, general conclusions may be formed. M. Dupré de St. Maur, a member of the French Academy, has executed this plan upon twelve parishes in the country of France, and three in Paris. Having obtained his permission to publish his tables, I do it the more cheerfully, as they are the only calculations by which the probability of human life, in general, can be ascertained with any degree of certainty.

		YEARS OF LIFE.				
		1	2	3	4	5
PARISHES.	Deaths.					
Clemont . . .	1,391	578	73	36	29	16
Brinon . . .	1,141	441	75	31	27	10
Jouy . . .	588	231	43	11	13	5
Lestiou . . .	223	89	16	9	7	1
Vandeuvre . .	672	156	58	18	19	10
St. Agil . . .	954	359	64	30	21	20
Thury . . .	262	103	31	8	4	3
St. Amant . .	748	170	61	24	11	12
Montigny . .	833	346	57	19	25	16
Villeneuve . .	131	14	3	5	1	1
Goussainville .	1,615	565	184	63	38	34
Ivry	2,247	686	298	96	61	50
Total deaths	10,805					
Division of 10,805 deaths into the years they happened.		3,738	963	350	256	178
Deaths before the end of 1st, 2d, &c years.		3,738	4,701	5,051	5,307	5,485
Number of persons entered into their 1st, 2d, &c. years		10,805	7,067	6,104	5,754	5,498
St. André . .	1,728	201	122	94	82	50
St. Hippolyte .	2,516	754	361	127	64	60
St. Nicolas .	8,945	1,761	932	414	298	221
Total Deaths	13,189					
Division of 13,189 deaths into the years they happened.		2,716	1,415	635	444	331
Deaths before the end of 1st, 2d, &c. years.		2,716	4,131	4,766	5,210	5,541
Number of persons entered into their 1st, 2d, &c. years.		13,189	10,473	9,058	8,423	7,979
Division of 23,994 deaths in the three parishes of Paris, and 12 country parishes.		6,454	2,378	985	700	509
Deaths before the end of 1st, 2d, &c. years.		6,454	8,832	9,817	10,517	11,026
Number of persons entered into their 1st, 2d, &c. years.		23,994	17,540	15,162	14,177	12,477

YEARS OF LIFE.

6	7	8	9	10	11	12	13
16	14	10	8	4	6	5	6
16	9	9	8	5	2	12	2
8	4	6	1	0	3	0	3
4	3	1	1	1	0	1	0
11	8	10	3	2	1	3	3
11	4	7	2	7	3	3	3
2	2	2	1	2	0	0	0
15	3	6	8	6	4	4	2
21	9	7	5	5	2	4	4
0	0	0	0	0	0	1	0
21	17	15	12	8	5	5	9
29	34	26	13	19	9	6	4
154	107	99	62	59	35	44	36
5,639	5,746	5,845	5,907	5,960	6,001	6,045	6,081
5,320	5,166	5,059	4,960	4,898	4,839	4,804	4,760
35	28	14	8	7	3	9	6
55	25	16	20	8	9	9	6
162	147	111	64	40	34	38	25
252	200	141	92	55	46	56	37
5,793	5,993	6,134	6,226	6,281	6,327	6,383	6,420
7,648	7,396	7,196	7,055	6,963	6,908	6,862	6,806
406	307	240	154	114	81	100	73
11,432	11,639	11,979	12,133	12,247	12,328	12,428	12,501
12,968	12,562	12,255	12,015	11,861	11,747	11,666	11,566

Parishes.	Deaths.	14	15	16	17	18
		YEARS OF LIFE.				
Clemont . . .	1,391	5	5	6	6	10
Brinon . . .	1,141	6	4	5	9	4
Jouy	588	3	1	6	4	4
Lestiou . . .	223	1	1	1	1	0
Vandeuvre . .	672	4	5	6	3	3
St. Agil . . .	954	3	5	2	7	8
Thury . . .	262	0	1	0	1	1
St. Amant . .	748	5	1	5	3	6
Montigny . .	833	2	4	2	2	3
Villeneuve . .	131	0	1	0	2	4
Goussainville .	1,615	5	5	2	5	10
Ivry	2,247	4	8	7	4	14
Total deaths	10,805					
Division of 10,805 deaths into the years they happened.		38	41	42	47	67
Deaths before the end of 14th, 15th, &c. years.		6,119	6,160	6,202	6,249	6,316
Number of persons entered into their 14th, 15th, &c. years.		4,724	4,686	4,645	4,603	4,556
St. André . .	1,728	7	10	13	13	11
St. Hippolyte .	2,516	7	6	5	7	9
St. Nicolas . .	8,945	21	33	37	37	28
Total deaths	13,189					
Division of 13,189 deaths into the years they happened.		35	49	55	57	48
Deaths before the end of 14th, 15th, &c. years.		6,455	6,504	6,559	6,616	6,664
Number of persons entered into their 14th, 15th, &c. years.		6,769	6,734	6,685	6,630	6,573
Division of 23,994 deaths in the three parishes of Paris, and 12 country parishes.		73	90	97	104	115
Deaths before the end of 14th, 15th, &c. years.		12,574	12,664	12,761	12,865	12,980
Number of persons entered into their 14th, 15th, &c. years.		11,493	11,420	11,330	11,233	11,129

YEARS OF LIFE.

19	20	21	22	23	24	25	26
3	13	8	9	10	7	22	9
5	14	8	14	7	11	24	9
3	5	2	4	4	4	5	2
0	0	0	0	3	0	1	1
4	7	4	6	8	6	22	3
5	6	4	6	3	6	11	10
1	1	1	3	1	1	2	2
1	4	7	6	6	4	5	4
3	5	4	3	10	8	7	3
0	1	1	4	1	0	1	0
9	10	6	10	5	6	11	9
10	12	6	15	10	9	10	14
44	78	51	80	68	62	121	66
6,360	6,438	6,480	6,569	6,637	6,699	6,820	6,886
4,489	4,445	4,367	4,316	4,236	4,168	4,106	3,985
10	7	9	17	11	9	9	8
7	3	2	8	7	9	10	13
44	53	31	56	48	41	59	47
61	63	42	81	66	59	78	68
6,725	6,788	6,830	6,911	6,977	7,036	7,114	7,182
6,525	6,464	6,401	6,359	6,278	6,212	6,153	6,075
105	141	93	161	134	121	199	134
13,085	13,226	13,319	13,480	13,614	13,735	13,934	14,068
11,014	10,909	10,768	10,675	10,514	10,380	10,259	10,060

		YEARS OF LIFE.				
Parishes.	Deaths.	27	28	29	30	31
Clemont . . .	1,391	13	10	7	24	4
Brinon . . .	1,141	7	13	6	28	6
Jouy	588	2	3	4	8	2
Lestiou . . .	223	1	3	1	1	4
Vandeuvre . .	672	5	10	1	28	2
St. Agil . . .	954	4	9	2	16	8
Thury . . .	262	0	5	2	2	0
St. Amant . .	748	4	3	3	8	2
Montigny . .	833	3	3	0	6	1
Villeneuve . .	131	2	1	1	2	1
Goussainville .	1,615	9	8	10	10	4
Ivry	2,247	5	9	5	13	8
Total deaths	10,805					
Division of 10,805 deaths into the years they happened.		55	77	42	146	42
Deaths before the end of 27th, 28th, &c. years.		6,941	7,018	7,060	7,206	7,248
Number of persons entered into their 27th, 28th, &c. years.		3,919	3,864	3,787	3,745	3,599
St. André . .	1,728	17	13	11	21	6
St. Hippolyte .	2,516	10	10	9	7	9
St. Nicolas . .	8,945	53	51	34	63	25
Total deaths	13,189					
Division of 13,189 deaths into the years they happened.		80	74	54	91	40
Deaths before the end of 27th, 28th, &c. years.		7,262	7,336	7,390	7,481	7,521
Number of persons entered into their 27th, 28th, &c. years.		6,007	5,927	5,853	5,799	5,708
Division of 23,994 deaths in the three parishes of Paris, and 12 country parishes.		135	151	96	237	82
Deaths before the end of 27th, 28th, &c., years.		14,203	14,354	14,450	14,687	14,769
Number of persons entered into their 27th, 28th, &c. years.		9,926	9,793	9,640	9,544	9,307

YEARS OF LIFE.

32	33	34	35	36	37	38	39
13	14	8	17	12	18	15	3
15	3	4	20	8	8	8	6
5	4	3	13	6	7	4	1
4	3	1	6	4	4	1	1
9	1	3	17	5	5	4	0
7	2	5	18	9	4	5	1
3	1	0	7	0	1	2	2
8	6	5	7	4	5	5	3
10	3	4	8	4	1	2	0
2	1	0	6	5	0	5	0
14	6	7	8	8	5	2	7
11	18	10	19	12	13	23	3
101	62	50	146	77	71	76	27
7,349	7,411	7,461	7,607	7,684	7,755	7,831	7,858
3,557	3,456	3,394	3,344	3,198	3,121	3,050	2,974
10	17	15	21	14	8	12	4
12	13	13	16	21	15	13	10
57	41	54	82	75	58	59	46
79	71	82	119	110	81	84	60
7,600	7,671	7,753	7,872	7,982	8,063	8,147	8,207
5,668	5,589	5,518	5,436	5,317	5,207	5,126	5,042
180	133	132	265	187	158	160	87
14,949	15,082	15,214	15,479	15,666	15,818	15,978	16,065
9,245	9,045	8,912	8,770	8,515	8,328	8,176	8,016

Parishes.	Deaths.	40	41	42	43	44
		YEARS OF LIFE.				
Clemont . . .	1,391	41	4	10	10	6
Brinon . . .	1,141	37	6	8	3	6
Jouy	588	20	0	3	0	4
Lestiou . . .	223	4	0	2	2	0
Vandeuvre . .	672	41	1	3	2	2
St. Agil . . .	954	22	2	8	7	3
Thury . . .	262	4	1	3	1	4
St. Amant . .	748	20	1	6	2	4
Montigny . .	833	8	3	6	5	4
Villeneuve . .	131	7	0	3	1	0
Goussainville .	1,615	14	10	11	4	5
Ivry	2,247	27	7	19	7	14
Total deaths	10,805					
Division of 10,805 deaths into the years they happened.		245	35	82	44	52
Deaths before the end of 40th, 41st, &c. years.		8,103	8,138	8,220	8,264	8,316
Number of persons entered into their 40th, 41st, &c. years.		2,947	2,702	2,667	2,585	2,541
St. André . .	1,728	26	5	19	12	10
St. Hippolyte .	2,516	24	4	18	14	9
St. Nicolas . .	8,945	109	37	73	58	45
Total deaths	13,189					
Division of 13,189 deaths into the years they happened.		159	46	110	84	64
Deaths before the end of 40th, 41st, &c. years.		8,366	8,412	8,522	8,606	8,670
Number of persons entered into their 40th, 41st, &c. years.		4,982	4,823	4,777	4,667	4,583
Division of 23,994 deaths in the three parishes of Paris, and 12 country parishes.		404	81	192	128	116
Deaths before the end of 40th, 41st, &c. years.		16,469	16,550	16,742	16,870	16,986
Number of persons entered into their 40th, 41st, &c. years.		7,929	7,525	7,444	7,252	7,124

YEARS OF LIFE.

45	46	47	48	49	50	51	52
20	5	8	5	6	31	0	5
11	5	6	9	0	23	1	3
13	3	4	2	0	20	2	3
3	3	0	3	3	5	1	1
14	5	3	1	0	31	0	2
14	1	3	3	0	24	3	9
3	0	0	0	0	3	0	0
13	3	4	6	0	23	1	4
13	6	1	6	1	10	2	5
2	1	2	3	0	7	2	1
11	9	5	12	6	15	4	9
22	10	7	12	6	24	6	14
139	51	43	62	22	216	22	56
8,455	8,506	8,549	8,611	8,633	8,849	8,871	8,927
2,489	2,350	2,299	2,256	2,194	2,172	1,956	1,934
24	21	9	13	10	24	7	18
33	14	13	15	12	20	10	19
111	54	47	68	50	120	40	59
168	89	69	96	72	164	57	96
8,838	8,927	8,996	9,092	9,164	9,328	9,385	9,481
4,519	4,351	4,262	4,193	4,097	4,025	3,861	3,804
307	140	112	158	94	380	79	152
17,293	17,433	17,545	17,703	17,797	18,177	18,256	18,408
7,008	6,701	6,561	6,449	6,291	6,167	5,817	5,738

		YEARS OF LIFE.				
Parishes.	Deaths.	53	54	55	56	57
Clemont . . .	1,391	5	5	14	5	5
Brinon . . .	1,141	3	2	10	6	2
Jouy	588	2	5	7	4	5
Lestiou . . .	223	0	0	2	2	0
Vandeuvre . .	672	1	1	13	1	1
St. Agil . . .	954	2	2	10	3	5
Thury . . .	262	1	1	4	0	1
St. Amant . .	748	4	4	6	5	4
Montigny . .	833	2	5	10	3	4
Villeneuve . .	131	0	1	0	3	1
Goussainville .	1,615	5	9	6	10	10
Ivry	2,247	13	9	29	12	13
Total deaths	10,805					
Division of 10,805 deaths into the years they happened.		38	44	111	54	51
Deaths before the end of 53d, 54th, &c. years.		8,965	9,009	9,120	9,174	9,225
Number of persons entered into their 53d, 54th, &c. years.		1,878	1,840	1,796	1,685	1,631
St. André . .	1,728	8	10	19	11	15
St. Hippolyte .	2,516	6	10	25	9	15
St. Nicolas . .	8,945	49	46	125	56	48
Total deaths	13,189					
Division of 13,189 deaths into the years they happened.		63	66	169	76	78
Deaths before the end of 53d, 54th, &c. years.		9,544	9,610	9,779	9,855	9,933
Number of persons entered into their 53d, 54th, &c. years.		3,703	3,645	3,579	3,410	3,334
Division of 23,994 deaths in the three parishes of Paris, and 12 country parishes.		101	110	280	130	129
Deaths before the end of 53d, 54th, &c. years.		18,509	18,619	18,899	19,029	19,158
Number of persons entered into their 53d, 54th, &c. years.		5,586	5,485	5,375	5,095	4,965

YEARS OF LIFE.

58	59	60	61	62	63	64	65
4	4	52	2	6	5	2	5
3	0	24	1	3	4	7	7
2	0	20	0	5	2	4	5
3	0	2	0	0	1	0	3
2	0	35	0	0	1	1	5
3	3	22	3	2	7	5	7
3	1	6	0	3	2	2	2
7	2	27	0	4	3	4	12
9	2	13	3	7	5	5	7
2	1	4	3	0	1	1	2
10	3	24	6	9	7	6	13
13	3	40	3	12	12	11	14
61	19	269	21	51	50	48	82
9,286	9,305	9,574	9,595	9,646	9,696	9,744	9,826
1,580	1,519	1,500	1,231	1,210	1,159	1,109	1,061
17	11	46	11	21	19	17	20
18	12	35	7	28	21	23	25
86	48	184	42	77	71	73	95
121	71	265	60	126	111	113	140
10,054	10,125	10,390	10,450	10,576	10,687	10,800	10,940
3,256	3,135	3,064	2,799	2,739	2,613	2,502	2,389
182	90	534	81	177	161	161	122
19,340	19,430	19,964	20,045	20,222	20,383	20,544	20,766
4,836	4,654	4,564	4,030	3,919	3,772	3,611	3,450

Parishes.	Deaths.	YEARS OF LIFE. 66	67	68	69	70
Clemont . . .	1,391	5	3	4	1	11
Brinon . . .	1,141	6	3	6	0	6
Jouy	588	2	1	1	1	3
Lestiou . . .	223	1	1	0	1	0
Vandeuvre . .	672	3	0	2	1	9
St. Agil . . .	954	3	6	5	2	19
Thury . . .	262	1	3	1	0	7
St. Amant . .	748	7	5	6	6	18
Montigny . .	833	6	2	5	1	9
Villeneuve . .	131	3	0	1	0	4
Goussainville .	1,615	17	13	15	5	16
Ivry	2,247	21	5	23	7	31
Total deaths	10,805					
Division of 10,805 deaths into the years they happened.		75	42	69	25	133
Deaths before the end of 66th, 67th, &c. years.		9,901	9,943	10,012	10,037	10,170
Number of persons entered into their 66th, 67th, &c. years.		979	904	862	793	768
St. André . .	1,728	27	21	25	9	36
St. Hippolyte .	2,516	19	12	20	13	35
St. Nicolas . .	8,945	95	67	115	50	177
Total deaths	13,189					
Division of 13,189 deaths into the years they happened.		141	100	160	72	248
Deaths before the end of 66th, 67th, &c. years.		11,081	11,181	11,341	11,413	11,661
Number of persons entered into their 66th, 67th, &c. years.		2,249	2,108	2,008	1,848	1,776
Division of 23,994 deaths in the three parishes of Paris, and 12 country parishes.		216	142	229	97	382
Deaths before the end of 66th, 67th, &c. years.		20,982	21,124	21,353	21,450	21,831
Number of persons entered into their 66th, 67th, &c. years.		3,228	3,012	2,870	2,641	2,544

YEARS OF LIFE.

71	72	73	74	75	76	77	78
1	3	1	3	5	1	1	2
2	12	2	0	4	2	0	3
1	2	0	1	1	0	0	0
0	2	0	0	0	0	0	0
1	4	0	0	3	0	1	0
1	11	5	5	8	0	3	4
0	2	1	0	0	0	1	0
3	10	2	2	18	2	4	4
2	8	3	2	9	1	4	2
0	3	0	0	0	0	2	1
8	22	12	12	16	6	6	8
6	21	11	19	24	12	11	14
25	100	37	44	88	24	33	38
10,195	10,295	10,332	10,376	10,464	10,488	10,521	10,559
635	610	510	473	429	341	317	284
9	25	14	19	20	16	10	25
10	28	5	15	23	11	13	15
64	118	53	90	127	63	59	69
83	171	72	124	170	90	87	109
11,744	11,915	11,987	12,111	12,281	12,371	12,458	12,567
1,528	1,445	1,274	1,202	1,078	908	818	731
108	271	109	168	258	114	120	147
21,939	22,210	22,319	22,487	22,745	22,859	22,979	23,126
2,160	2,155	1,784	1,675	1,507	1,249	1,135	1,015

		YEARS OF LIFE.				
		79	80	81	82	83
PARISHES.	Deaths.					
Clemont . . .	1,391	2	6	0	0	0
Brinon . . .	1,141	0	3	1		
Jouy	588	0	2	0	0	0
Lestiou . . .	223	0	3	0	0	0
Vandeuvre . .	672	0	7	0	0	0
St. Agil . . .	954	0	6	0	0	0
Thury . . .	262	0	3			
St. Amant . .	748	2	17	1	3	1
Montigny . .	833	0	5	1	4	1
Villeneuve . .	131	1	1	0	0	0
Goussainville .	1,615	1	17	6	9	5
Ivry	2,247	9	19	7	14	4
Total deaths	10,805					
Division of 10,805 deaths into the years they happened.		15	89	16	30	11
Deaths before the end of 79th, 80th, &c. years.		10,574	10,663	10,679	10,709	10,720
Number of persons entered into their 79th, 80th, &c. years.		246	231	142	126	96
St. André . .	1,728	8	17	4	10	8
St. Hippolyte .	2,516	8	18	4	5	16
St. Nicolas . .	8,945	30	121	32	41	37
Total deaths	13,189					
Division of 13,189 deaths into the years they happened.		46	156	40	56	61
Deaths before the end of 79th, 80th, &c. years.		12,613	12,769	12,809	12,865	12,926
Number of persons entered into their 79th, 80th, &c. years.		622	576	420	380	324
Division of 23,994 deaths in the three parishes of Paris, and 12 country parishes.		61	245	56	86	72
Deaths before the end of 79th, 80th, &c. years.		23,187	23,432	23,488	23,574	23,646
Number of persons entered into their 79th, 80th, &c. years.		868	807	562	506	420

YEARS OF LIFE.

84	85	86	87	88	89	90	91
3	0	1	0	0	1		
0	0	0	0	1			
0	1						
0	0	0	1	1			
0	0	0	0	0	0	2	0
3	4	0	1	2	0	4	1
1	0	0	0	0	0	1	
0	0	0	0	0	1		
7	2	4	4	2	2		
7	5	4	2	3	1	2	0
21	12	9	8	9	5	9	1
10,741	10,753	10,762	10,770	10,779	10,784	10,793	10,794
85	64	52	43	35	26	21	12
7	3	7	4	5	2	4	0
4	10	4	1	4	2	2	2
25	35	19	20	25	4	17	5
36	48	30	25	34	8	23	7
12,962	13,010	13,040	13,065	13,099	13,107	13,130	13,137
263	227	179	149	124	90	82	59
57	50	39	33	43	13	32	8
23,703	23,763	23,802	23,835	23,878	23,891	23,923	23,931
348	291	231	192	159	116	108	71

Parishes.	Deaths.	YEARS OF LIFE. 92	93	94	95	96
Clemont . . .	1,391					
Brinon . . .	1,141					
Jouy	588					
Lestiou . . .	223					
Vandeuvre . .	672					
St. Agil . . .	954	0	0	0	0	0
Thury . . .	262					
St. Amant . .	748	1	0	0	2	1
Montigny . .	833					
Villeneuve . .	131					
Goussainville .	1,615					
Ivry	2,247	2	0	0	1	0
Total deaths	10,805					
Division of 10,805 deaths into the years they happened.		3	0	0	3	1
Deaths before the end of 92d, 93d, &c. years.		10,797	10,797	10,797	10,800	10,801
Number of persons entered into their 92d, 93d, &c. years.		11	8	8	8	5
St. André . .	1,728	2	1	2	0	1
St. Hippolyte .	2,516	2	1	1	2	1
St. Nicolas . .	8,945	9	5	4	5	2
Total deaths	13,189					
Division of 13,189 deaths into the years they happened.		13	7	7	7	4
Deaths before the end of 92d, 93d, &c. years.		13,150	13,157	13,164	13,171	13,175
Number of persons entered into their 92d, 93d, &c. years.		52	39	32	25	18
Division of 23,994 deaths in the three parishes of Paris, and 12 country parishes.		16	7	7	10	5
Deaths before the end of 92d, 93d, &c. years.		23,947	23,954	23,961	23,971	23,976
Number of persons entered into their 92d, 93d, &c. years.		63	47	41	33	23

Parishes.	Deaths.	97	98	99	100
		YEARS OF LIFE.			
Clemont . . .	1,391				
Brinon . . .	1,141				
Jouy	588				
Lestiou . . .	223				
Vandeuvre . .	672				
St. Agil . . .	954	0	0	0	1
Thury . . .	262				
St. Amant . .	748	0	3		
Montigny . .	833				
Villeneuve . .	131				
Goussainville .	1,615				
Ivry	2,247				
Total deaths	10,805				
Division of 10,805 deaths into the years they happened.		0	3	0	1
Deaths before the end of 97th, 98th, &c. years.		10,801	10,804	10,804	10,805
Number of persons entered into their 97th, 98th, &c. years.		4	4	1	1
St. André . .	1,728	1	0	0	0
St. Hippolyte .	2,516	0	1		
St. Nicolas . .	8,945	1	4	1	4
Total deaths	13,189				
Division of 13,189 deaths into the years they happened.		2	5	1	4
Deaths before the end of 97th, 98th, &c. years.		13,177	13,182	13,183	13,187
Number of persons entered into their 97th, 98th, &c. years.		14	12	7	6
Division of 23,994 deaths in the three parishes of Paris, and 12 country parishes.		2	8	1	5
Deaths before the end of 97th, 98th, &c., years.		23,978	23,986	23,987	23,992
Number of persons entered into their 97th, 98th, &c. years.		18	16	8	7

Many useful conclusions might be drawn from the above tables of M. Dupré. But I shall confine myself to those which regard the probabilities of the duration of life. In the columns under the years, 10, 20, 30, 40, 50, 60, 70, 80, and other round numbers, as 25, 35, &c., there are, in the country parishes, more deaths than in the preceding or subsequent columns. This is owing to the ages not being justly registered, most country people being unable to ascertain their ages within less than two or three years. If they die at 58 or 59, they are registered at 60, and so of other round numbers. But this irregularity gives rise to no great inconvenience, as it can easily be corrected by the manner in which the numbers succeed each other in the tables.

It appears, from the tables of the country parishes, that one half of the children die nearly about the end of the fourth year; but, from the Paris table, sixteen years are necessary to produce the same effect. This great difference proceeds from a general practice of the Parisians, who send their children to be nursed in the country, which necessarily increases the number of deaths during the first years of infancy. In the following calculation, I have estimated the probabilities of the duration of life from a combination of both tables; which must, therefore, make a very near approach to the truth.

TABLE, showing the Probabilities of the Duration of Human Life.

Age.	Dur. of Life.		Age.	Dur. of Life.		Age.	Dur. of Life.	
Yrs.	Yrs.	Mths.	Yrs.	Yrs.	Mths.	Yrs.	Yrs.	Mths.
0	8	0	29	28	6	58	12	3
1	33	0	30	28	0	59	11	8
2	38	0	31	27	6	60	11	1
3	40	0	32	26	11	61	10	6
4	41	0	33	26	3	62	10	0
5	41	6	34	25	7	63	9	6
6	42	0	35	25	0	64	9	0
7	42	3	36	24	5	65	8	6
8	41	6	37	23	10	66	8	0
9	40	10	38	23	3	67	7	6
10	40	2	39	22	8	68	7	0
11	39	6	40	22	1	69	6	7
12	38	9	41	21	6	70	6	2
13	38	1	42	20	11	71	5	8
14	37	5	43	20	4	72	5	4
15	36	9	44	19	9	73	5	0
16	36	0	45	19	3	74	4	9
17	35	4	46	18	9	75	4	6
18	34	8	47	18	2	76	4	3
19	34	0	48	17	8	77	4	1
20	33	5	49	17	2	78	3	11
21	32	11	50	16	7	79	3	9
22	32	4	51	16	0	80	3	7
23	31	10	52	15	6	81	3	5
24	31	3	53	15	0	82	3	3
25	30	9	54	14	6	83	3	2
26	30	2	55	14	0	84	3	1
27	29	7	56	13	5	85	3	0
28	29	0	57	12	10			

From this table, it appears, that a new born infant, or a child of 0 age, has an equal chance of living 8 years; that a child of 1 year will live 33 more; that a child of two years will live 38 more; that a man of 20 years will live 33 and 5 months more; that a man of 30 years will live 28 more, &c.

It may be farther observed, 1. That 7 years is the age at which the longest duration of life is to be expected; for there is then an equal chance of surviving 42 years 3 months; 2. That, at 12 years, one fourth of life is expired, since we have no reason to hope for above 38 or 39 years more; 3. That at 28 or 29 years, we have lived one half of our days, since there are only 28 more to be expected; and, lastly, That, at the age of 50, three fourths of life are gone, the remaining chance extending only to 16 or 17 years longer.

But these physical truths, however mortifying, may be alleviated by moral considerations. The first 15 years of our existence may be regarded as nothing: every thing that passes during this long period, is either obliterated from the memory, or has so little connexion with the views and objects which afterwards occupy our attention, that it ceases entirely to be interesting. The train of our ideas, and even the nature of our existence, suffer a total change. We begin not to live, in a moral sense, till after we have learned to arrange our thoughts, to direct them towards futurity, to assume a kind of consistency

of character similar to that state at which we are ultimately destined to arrive. Considering the duration of life in this point of view, which is the only real one, at the age of 25, we have passed one fourth of our days; at the age of 38, one half; and, at the age of 56, three fourths.

SECT. VI.

Of the Sense of Seeing.

WE have already described the parts of which the human body consists; and shall now proceed to examine those curious organs by which sensations are conveyed to the mind. In this investigation, we shall endeavour to point out the uses of the different senses, and to mark those errors to which we are, in some measure, subjected by Nature.

In the human fœtus, the eyes are early formed; in the chicken, also, they are the first double organs which make their appearance; and, in the eggs of lizards, and of several species of birds, I have remarked, that the eyes were more prominent and advanced in growth than any other double parts of the body. In viviparous animals, it is true, and particularly in the human fœtus, the eyes are not so large, in proportion, as in the oviparous; but still they are more quickly expanded than the other parts of the system. The same remark applies to the organ of hearing. The small bones of the ear are fully formed before the other bones of the body have acquired any degree of solidity or bulk. In the seventh month, the whole bones of the ear are perfectly solid, and have acquired all the

density they possess in the adult state. It is, therefore, apparent, that those parts which are furnished with the greatest quantity of nerves, are first formed and expanded. We formerly remarked, that the vesicles which contain the brain and cerebellum, and that which contains the spinal marrow, appear first. The spinal marrow is a fundamental and essential part of the body, and is therefore first formed. Hence the nerves exist before any of the other parts of the body, and those organs which are most amply supplied with them, as the ears and eyes, are most quickly expanded.

Upon examining the eyes of an infant some hours after birth, it is easy to perceive that it can make no use of them: this organ not having acquired a sufficient degree of consistence, the rays of light make a confused impression only on the retina. About a month after birth, the eye seems to have acquired that tension and solidity which are necessary for the proper transmission of the rays of light; but, even then, infants are incapable of fixing their eyes upon any object: they roll and move them to all sides, without being able to distinguish the objects to which their eyes are directed. In six or seven weeks, however, they begin to fix their attention upon luminous objects. But this exercise tends only to fortify the eye, without conveying any exact perception of different objects; for the first great error in vision, is the inverted representation of objects upon the retina: and,

till children learn the real position of bodies by the sense of feeling, they see every object inverted. A second error in the vision of infants arises from the double appearance of objects; because a distinct image of the same object is formed on the retina of each eye. It is by the experience of feeling bodies only, that children are enabled to correct this error. By the frequent handling of objects, they gradually learn that they are neither double nor inverted; and custom soon makes them imagine they see objects in the order and position in which they are represented to the mind by the sense of touching. Hence, if we were deprived of feeling, our eyes would deceive us, both with regard to the position and number of objects.

The inversion of objects is a result of the structure of the eye; for the rays which form the images of these objects cannot enter the pupil without crossing each other. This admits of an easy proof: when light is transmitted through a small hole into a dark chamber, the images of the objects from without are represented on the wall in an inverted position; because all the rays reflected from the different points of the object cannot pass through this small hole, in the same extent and position as they proceed from the object, unless the hole be of equal dimensions with the object. But, as every part of the object reflects images of itself on all sides, and, as the rays which form these

images proceed from every point of the object as from so many centres, none of them can pass through the hole but those that arrive at it in different directions. Hence the hole becomes the centre of the whole object, at which the rays flowing from the lower, as well as the higher parts of the object, arrive in converging directions; and, of course, they must cross each other at this centre, and represent the picture of the object on the opposite wall in an inverted position.

It is equally easy to show that we see all objects double: if, for instance, we look at an object with the right eye, we will find that it corresponds with a certain point of the wall; if we look at the same object with the left, it then corresponds with a different point; and, lastly, when we look at it with both eyes, it appears in the middle between these points. Thus an image of the object is formed on both eyes, one of which appears on the left, and the other on the right; and we perceive it to be single and in a middle situation, because we have learned to correct this error of vision by the sense of touching. In the same manner, if we look with both eyes at two objects, nearly in the same direction, by fixing our eyes on the nearest, we perceive it to be single; but the farthest appears to be double; and, if we fix our eyes on the farthest, it appears to be single, while the nearest is perceived to be double. This is an evident proof, that we see all objects double, though we conceive them to be single; and that, though

we form an accurate idea of their real situation, yet we actually see them where they are not. If, therefore, the sense of seeing were not constantly rectified by that of touching, we would be perpetually deceived as to the position, number, and situation of objects; we would perceive them to be inverted, double, and to the right or left of their real situations; and, instead of two, if we had 100 eyes, we would still conceive objects to be single, though they were in reality multiplied a hundred fold.

Thus a separate image of every object is formed in each eye; and, when the two images fall on corresponding parts of the retina, or those parts which are always affected at the same time, objects appear single, because we are accustomed to judge of them in this manner. But, when the images of objects fall upon parts of the retina which are not usually affected at the same time, they then appear double, because we have not acquired the habit of rectifying this unusual sensation.

Mr. Chesselden, in his Anatomy *, relates the case of a man who had been affected with a strabismis, in consequence of a blow on the head. This man saw every object double for a long time. But he gradually learned to correct this error of vision, with regard to objects which were most familiar to him; and, at last, he saw every object single, as formerly, though the squinting of his eyes was never removed. This

* Page 324.

is a proof, still more direct, that we really see all objects double, and that it is by habit alone we learn to conceive them to be single. If it should be asked, why children sooner acquire the faculty of correcting this deception than adults whose eyes have been distorted by accident? it may be replied, that children having acquired no opposite habits, less time is, of course, necessary to correct the errors of their sensations; but that adults, who have for many years been accustomed to perceive objects single, because their images fall upon corresponding parts of the retina, have a contrary habit to oppose, and, consequently, must require a long time before they can obviate its effects.

The sense of seeing conveys no idea of distances. Without the aid of touching, all objects would appear to be within the eye, because it is there alone that their images exist: and an infant, who has had no experience of the sense of touching, must consider all external bodies as existing in itself: they appear larger or smaller only according as they approach or recede from the eye. A fly, when near the eye, will seem larger than an ox or a horse at a distance. Thus an infant can have no idea of the relative magnitude of objects, because he has no notion of the different distances at which he views them. It is only after measuring space by the extension of the hand, or by transporting their bodies from one place to another, that children acquire correct ideas concerning the distances and magnitudes of objects. Before this period, they can

form no judgment of the distance or magnitude of an object, but by the image painted on the retina. Their ideas of magnitude entirely result from the angle formed by the extreme rays reflected from the superior and inferior parts of the object: of course, every near object must appear to be large, and every distant object small. But, after having acquired, by touch, ideas of distances, the judgment concerning magnitude begins to be rectified: they trust not alone to the apparent magnitude conveyed by the eye: they endeavour to investigate the distance; they try, at the same time, to distinguish the object by its form; and then they judge of its magnitude.

If we judge by the eye alone, and have not acquired the habit of apprehending the same objects to be equally large, though viewed at different distances, the first soldier, in a file of twenty, must appear much larger than the last. But we know the last soldier to be equally large with the first; and hence we judge him to be of the same dimensions. And, as we have the habit of considering the same object to be of equal magnitude at all ordinary distances, we are never deceived on this head, except when the distance is too great, or when the interval is in an uncommon direction. A distance ceases to be familiar to us whenever it is too large, or rather when the interval is vertical instead of horizontal. The first ideas of the comparative magnitude of objects we acquire either by measuring their relative distances by the hand, or by moving the whole body. But all the experiments by which

we commonly rectify the errors of vision, with regard to distances, are made horizontally. We have no acquired habit of judging of the magnitude of objects which are elevated above, or sunk below us; because we are not accustomed to measure in this direction by the touch. Hence, when viewing men from the top of a tower, or when looking up to a cock or a globe on the top of a steeple, we think these objects are much more diminished than if we viewed them at equal distances in a horizontal direction.

Though a small degree of reflection be sufficient to convince us of the truth of these positions, it may still be of use to relate the facts which confirm them. The celebrated Cheselden couched cataracts in both eyes of a youth of thirteen years of age, who had been blind from his birth. The operation succeeded; and Mr. Cheselden carefully observed the manner in which the young man was affected by the sense of seeing. These observations he published in the Philosophical Transactions*. This young man was not absolutely blind: like other persons affected with cataracts, he could distinguish night from day, and even black from white; but he had not the most distant conception of the figure of bodies. The operation was first performed in one eye. When he saw for the first time, he was so far from judging of distances, that he believed every object touched his eyes in the same manner as every thing he handled touched his skin.

* See Phil. Trans. num. 402, and Tatler, art. 55.

Objects of a regular figure, and having plain surfaces, were most agreeable to him, though he was still incapable of forming any judgment as to their form, or telling why they afforded him more pleasure than others. His ideas of colours before the operation were so faint, that, after receiving his sight, he was unable to distinguish one from another. He insisted that the colours which he then saw were not the same he was formerly acquainted with. He knew not the figure of any object; nor could he distinguish one from another, however different in form and in magnitude. When presented with things which were formerly familiar to him, he observed them with attention, that he might be able to know them afterwards. But, as he had too many objects to recognise at once, he forgot the greatest part of them; and, from his commencing to distinguish objects, he did not retain in his memory one out of a thousand. Those objects and persons which were formerly most beloved by him, he was astonished to find were not also the most agreeable to his sight. It was more than two months before he could perceive that pictures were the representations of solid bodies. Previous to this period, he considered them only as plain surfaces diversified by different colours. But, after he began to perceive that pictures represented solid bodies, he expected to recognise their seeming inequalities by touching the canvas; and was perfectly astonished when he found the whole uniformly smooth. He asked, whether the deception arose from the sense of

feeling or that of seeing? He was then shown a miniature portrait of his father, contained in his mother's watch case. He recognised the resemblance of his father: but he inquired with amazement how so large a countenance could possibly be contained in so small a compass; for it appeared to him equally strange, as that a bushel should be held in a pint vessel. At first, his eye could support a small quantity of light only; and every object seemed much larger than the life: but, after he had seen objects of large dimensions, former objects appeared to be proportionally diminished. He had no conception that any objects exceeded the limits of those he had already seen. He knew that his own apartment was only a part of the house, and yet he was unable to comprehend how the house should be larger than his chamber. Before the operation, he expected not much pleasure from the acquisition of the new sense that had been promised him, except what should arise from his being enabled to read and write. He alleged, for example, that he could receive no new satisfaction from walking in the garden, because he already knew every corner of it, and could walk there with great ease and freedom. He had even remarked, that his blindness gave him the advantage of walking in the night with more confidence and security than those who enjoyed the benefit of sight. But, after he began to have the proper use of this new sense, he was transported beyond measure. He declared that every new object afforded a fresh delight; and that the pleasure he felt exceeded the powers of

expression. About twelve months after the operation, he was conducted to Epsom, from which there is a beautiful and extensive prospect. He was charmed with the view; and he called this landscape a new mode of seeing.

About a year after the first operation, the cataract on the other eye was couched with equal success. With this second eye he perceived objects to be much larger than with the other, but not so large as when he first received sight; and when he viewed the same object with both eyes, he said that it appeared to be twice as large as with the first eye alone. But, after he procured the use of both eyes, he did not see objects double, or, at least, Mr. Chesselden could not be certain that he did.

Mr. Chesselden records several other examples of blind men, who had no remembrance of light, restored to vision by the same operation; and he assures us, that, when they first obtained the use of their eyes, they expressed their perceptions in a similar manner, though not so minutely: and he remarks upon the whole, that as, during their blindness, they had no occasion to move their eyes, it cost them much difficulty, and a considerable time, before they could acquire the faculty of directing them to the objects they wished to examine *.

As, from particular circumstances, we can have no just idea of distance, and as we cannot judge concerning the magnitude of objects, but

* See Lettre sur les aveugles, a l'Usage de ceux qui voient.

by the largeness of the angle or image formed in the eye, we must necessarily be subject to deceptions with regard to these articles. Every body knows how liable we are, when travelling in the night, to mistake a bush that is near us for a tree at a distance, or a distant tree for a bush which is at hand. In the same manner, if we are unacquainted with the figure of objects, we cannot form any idea either of their distance or magnitude: a fly passing with rapidity at some inches from the eye, would, in this case, appear like a bird at a considerable distance; and a horse standing in the middle of a plain, would not seem larger than a sheep. But, as soon as we knew it to be a horse, it would instantly appear as large as the life, because we have the power of correcting this deception of vision.

Whenever, therefore, we are benighted in a part of the country with which we are unacquainted, being unable, on account of the darkness, to judge of the distance or figure of objects, we are every moment liable to all the deceptions of vision. This is the source of that dread which most people feel in the dark, and of those spectres and terrible figures which so many persons tell us they have seen in the night. Though such figures, it is commonly asserted, exist in the imagination only, yet they may have a real existence in the eye; for, whenever we have no other mode of judging of an unknown object but by the angle it forms in the eye, its magnitude will uniformly increase in proportion to its propinquity. If it appears, when at the distance of twenty or thirty paces, to be only a few feet

high, its height, when within two or three feet of the eye, will be many fathoms. An object of this kind must naturally excite terror and astonishment in the spectator, till he approaches and recognises it by actual feeling; for the moment a man knows an object, the gigantic appearance it assumed in the eye instantly diminishes, and its apparent magnitude is reduced to its real dimensions. But if, instead of approaching such an object, the spectator flies from it, he can have no other idea of it, but from the image which it formed in his eye; and, in this case, he may affirm with truth, that he saw an object terrible in its aspect, and enormous in its size. Thus the notions concerning spectres are founded in nature, and depend not, as some philosophers affirm, upon the imagination alone.

When we are unable to form an idea of the distance of objects by the knowledge of the space between them and the eye, we endeavour to judge of their magnitude by distinguishing their figures. But, when the figures are not distinguishable, and when we view a number of objects of the same form, we conceive those that are most brilliant to be nearest, and those which are most obscure to be at the greatest distance. This mode of judging gives rise to deceptions of a singular nature. When a multitude of objects are disposed in a right line, as the lamps on the road from Versailles to Paris, of the proximity or remoteness of which we can only judge by the different quantities of light they transmit to the eye, it frequently happens, when viewed at the distance of an eighth of a league, that the lamps

appear to be on the right hand, in place of the left. This deception is an effect of the cause above mentioned; for, as the spectator has no other criterion to judge of the distance of the lamps, but the quantity of light they emit, he thinks the most brilliant of them is nearest to his eye. Now, if the first two or three lamps should happen to be most obscure, or if one in the whole range was more brilliant than the rest, that one, to a spectator, would seem to be the first, and all the others, whatever might be their real situation, would seem to be placed behind it. This apparent transposition could not be effected by any other means than a change of situation from left to right; for, in a long range of objects, we cannot apprehend what is really behind to be situated before any one of these objects, without seeing on the right what is on the left, or on the left what is on the right.

I have thus mentioned the principal defects of the sense of seeing; and shall now proceed to examine the nature, properties, and extent of that admirable organ, by which we are enabled to have a communication with the most distant objects. Sight is a species of touching, but very different from the common species of that sense. Before we can touch any object, we must either approach it with some part of our body, or it must approach us. But, with the eye, we can touch any object, however distant, if it transmits a sufficient quantity of light to make an impression on, or if its picture forms a sensible angle in the eye. The smallest visible angle is about one

minute. This angle, when an object is viewed at the greatest distance of vision, is about the 3,436th part of the diameter of that object. An object, for example, of a foot square, ceases to be visible at the distance of 3,436 feet. A man of five feet high is not visible beyond the distance of 17,180 feet, when the sun shines.

But, with regard to the extent of human vision, an observation occurs, which seems to have escaped all the writers on optics: the extent of our sight diminishes or augments in proportion to the quantity of light that surrounds us, supposing the illumination of the object to remain the same. If the same object which we see during the day at the distance of 3,436 times its diameter, were equally illuminated during the night, it would be visible at a distance 100 times greater. A candle is visible in the night at the distance of more than two leagues; that is, supposing the diameter of the luminary to be one inch, it would be visible at the distance of 316,800 times the length of its diameter. But, in the day, this candle would not be discernible beyond ten or twelve thousand times the length of its diameter. The same remark is applicable to all objects, when viewed during the day or the night. We may, therefore, conclude, that the extent of our vision is much greater than our first supposition; and that the reason why we are often unable to distinguish distant objects, is less owing to a defect of light, or to the smallness of the angle under which they are painted in the eye, than to the profusion of rays re-

flected from intermediate objects, which, by their brilliancy, prevent us from perceiving the fainter and more diverging rays that proceed from distant objects. The retina of the eye is like a canvas upon which objects are painted. The colour of those pictures is bright or obscure in proportion to the distances of the objects represented. When objects are very remote, their pictures on the retina are so faint, that they are entirely obliterated by the vigorous and lively impressions made by nearer objects, with which we are every where environed. But, when the intermediate objects emit a feeble light only, compared with that which proceeds from remote objects, as, for example, when we view a luminous body in the night time, then the distant object makes a distinct picture on the retina, and becomes perfectly visible. It is a consequence of these facts, that a man, by placing himself in the dark, and employing a long tube, may make a telescope, which will have a considerable effect even during the day. For the same reason, a man at the bottom of a deep pit can see the stars at noon; and this fact was not unknown to the ancients, as appears from the following passage of Aristotle: "Manu enim admota, aut per fistulam, longius cernet. Quidam ex foveis puteisque interdum stellas conspiciunt."

We may, therefore, affirm, that the human eye is capable of being affected with objects which subtend not an angle above a second, or less, even when they reflect no more light than when they were seen under an angle of one

minute; and, consequently, that the powers of this organ are greater than was formerly imagined. But, if objects, without forming a greater angle, were furnished with a more intense light, we would see them at still greater distances. A small taper, when vivid, is seen much farther than a flambeau that emits a dim light. In order to determine the utmost distance at which an object can be rendered visible, three things must be considered: 1. The largeness of the angle formed in the eye; 2. The degree of light with which the neighbouring and intermediate objects are illuminated; and, 3. The intensity of the light proceeding from the object itself. Vision is affected by each of these causes; and it is only by estimating and comparing them, that we can determine the distance at which any particular object can be discerned. The following is a demonstrative proof of the influence of intensity of light upon vision. Telescopes and microscopes are known to be instruments of the same kind, each of them increasing the visible angle of objects, whether they be really minute, or appear so on account of their distance. Why then do telescopes with difficulty magnify objects a thousand times, when a good microscope magnifies more than a million? This difference, it is apparent, proceeds from the degree of light only; for, if we could illuminate distant objects with an additional quantity of rays, they would appear infinitely clearer, though seen under the same angle, and telescopes would have the same effect upon distant objects as microscopes have

upon those which are minute. But this is not a proper place for expatiating on these subjects.

The distance at which any object can be seen is seldom the same in both eyes. There are few men who have both eyes equally strong. When this inequality is great, the strongest eye is most generally employed, which is the cause of squinting, as I have elsewhere proved*. When both eyes are equally strong, and directed to the same object, one should imagine that the vision would be doubly distinct; but the difference has been found by experiment to be only one thirteenth part†; and this phænomenon may admit of the following solution. The two optic nerves, near the place where they come out of the skull, unite, and then separate by an obtuse angle, before they enter the eyes. The motion communicated to these nerves by the impression of objects on the retina, cannot be transmitted to the brain without passing the united part. Hence these two motions must be combined, and produce a similar effect, as when two bodies moving upon two sides of a square, and impinging on a third, make it move in the diagonal. Now, if the angle were about 115 or 116 degrees, the diagonal would be to the side as 13 to 12, which is the same ratio that the sensation resulting from both eyes bears to that which results from one. The angle formed by the two optic nerves being nearly equal to that supposed above, the loss of sensation may be attributed to this position of the nerves; and this

* See Mem. de l'Acad. ann. 1743.

† See Jurin's Essays on distinct and indistinct Vision.

loss will always increase in proportion to the greatness of the angle.

Short-sighted persons are generally supposed to see objects larger than other men. But the reverse is the truth; for they actually see them diminished. I myself am short-sighted, and my left eye is stronger than my right. I have a thousand times examined the same objects, as the letters of a book, at the same distance, first with one eye, and then with the other, and uniformly found that objects appeared both clearest and largest to the left eye; and, when I distorted one of my eyes to make an object appear double, the image presented to the right eye was less than the other. I cannot, therefore, hesitate in pronouncing, that the more short-sighted any man is, he sees objects proportionally diminished. I examined several persons who had eyes unequal in strength, and all of them declared that they saw objects larger with the strong than with the weak eye. This phænomenon is perhaps the effect of habit; for short-sighted people, being accustomed to approach close to objects, and to view a small portion of them only at a time, their eyes acquire a standard of magnitude much less than other men, who can take in at once all the parts of large bodies.

Short-sightedness has been often ascribed to a roundness or prominence of the eyes. But this cause is not satisfactory; for some have suddenly become short-sighted, as the young man mentioned by Mr. Smith in his Optics *, who became

* Vol. ii. page 10.

short-sighted on coming out of a cold bath, and who, from that period, was always obliged to use a concave glass. It cannot be supposed that the crystalline and vitreous humours were all at once inflated to such a degree as to produce this difference in vision. Short-sightedness may as well proceed from the respective position of the different parts of the eye, and especially of the retina, as from the form of the humours; it may proceed from a less degree of sensibility in the retina, from a smallness of the pupil, &c. In the two latter cases, it is true, concave glasses would be useless, and even hurtful; in the two former, they may be employed with advantage. But still, objects seen through these glasses are neither so distinct, nor perceived at such a distance, as other men see them with the naked eye; because short-sighted persons, as formerly remarked, see the pictures in a diminished form, and concave glasses diminish them still farther: whenever, therefore, these pictures become so small as to make too faint an impression on the retina, they cease to be visible; consequently, people who labour under this defect see not so far with the assistance of glasses as other men do with their eyes.

As the eyes of infants are less than those of adults, they must likewise see objects less; because the greatest angle which an object can form in the eye must always be proportioned to the dimensions of the retina: if the field of the retina, where the pictures of objects are formed, be supposed to be half an inch in adults, it will not exceed a third or a fourth of an inch in in-

fants. Children, of course, cannot see so far as adults; for, as objects appear less to them, they must sooner become invisible. But as, in infants, the pupils are larger, in proportion to the size of their eyes, than those of adults, they may derive some small advantage from this circumstance.

Old men, as the humours of their eyes are said to be dried up, ought to see nearer than young men: but the reverse is true; for old men see best at a distance. This alteration cannot proceed entirely from a diminution, or a flattening of the humours of the eye, but rather from a change of position between its parts, as between the cornea and the crystalline, or between the vitreous humour and the retina. This may be easily understood, by supposing that the cornea becomes more solid as we advance in years, and, consequently, that it cannot readily assume that convexity which is necessary in order to see near objects; and, as it must be flattened by drying, this circumstance alone is sufficient to make old men see best at a distance.

Clear and *distinct* vision, though different in their nature, are terms very generally confounded by writers on optics. We see an object *clearly*, whenever it is sufficiently illuminated to enable us to form a general idea of its figure; but we see it not *distinctly*, till it be so near that we can examine all its parts. When we view a distant tower, we see it clearly as soon as we perceive it to be a tower; but we see it not distinctly till we approach so near as to be able to determine not only its general dimensions, but to distinguish

the parts of which it is composed, as the order of architecture, the materials, the windows, &c. We may, therefore, see an object clearly without seeing it distinctly, and we may see it distinctly without seeing it clearly; because distinct vision implies a successive examination of the different parts of objects. Old men see clearly, but not distinctly: they perceive large or luminous objects at a distance; but they are unable to distinguish small objects, as the characters of a book, without the assistance of magnifying glasses. Short-sighted persons, on the contrary, see small objects distinctly; but they have no clear vision of large objects, unless they are diminished by concave glasses. A great quantity of light is necessary for clear vision, and a small quantity is sufficient for distinct vision. Hence short-sighted people see better in the night than other men.

When an object is too brilliant, or when the eye fixes too long upon the same object, the organ is injured or fatigued, vision becomes indistinct, and the image of the object, having made an impression too violent, or remained too long on the retina, seems, for some time, to be painted on every body we look at. But I will not enlarge on this subject, because I have elsewhere given a full explication of it*. I shall only observe, that nothing perhaps is more destructive to the eye than too great a quantity of light. Blindness is exceedingly frequent in the

* See Mem. de l'Acad. ann. 1743.

northern regions, where the snow, illuminated by the rays of the sun, obliges travellers to cover their eyes with crape, to prevent the dangerous, and often sudden effects of too much light. In the sandy deserts of Arabia, the reflection of the light is so violent, that the eyes are unable to support it. Such persons, therefore, as are obliged to write or read long at a time, should beware of using a strong light.

MAHARAJA SERFOGI'S S... THE TANJORE ... MAHAL.

SECT. VII.

Of the Sense of Hearing.

THE sense of hearing, like that of seeing, conveys perceptions of distant objects; it is, of course, subject to similar errors, and must deceive us, when we have no opportunity of rectifying, by the touch, the ideas it excites. The sense of hearing communicates no distinct intelligence of the distance of sonorous bodies. A great noise at a distance, and a small one when near, produce the same sensation; and, unless we derive aid from the other senses, we cannot distinguish the distance of the one from that of the other.

When we hear an unknown sound, we can neither judge of the distance, nor of the momentum of the stroke which gives rise to it. But, whenever we can ascertain the species of any individual sound, we are able to guess both at the distance and momentum of the stroke. If, for example, we hear the report of a cannon, or the sound of a bell, we compare them with those of the same kind which we have formerly heard, and form a gross judgment both of their distance and momentum.

Every body that impinges on another produces sound: this sound, in nonelastic bodies, is

simple, but multiplied in those which are elastic. When we strike a bell, a single stroke produces a sound, which is successively repeated as long as the sonorous body continues to vibrate. If, therefore, we had not acquired the habit of judging every sound to be single which is produced by one stroke, we would conceive all sounds to be multiplied. On this subject, I shall relate an incident that happened to myself. When lying in bed, half asleep, my clock struck, and I counted five strokes of the hammer on the bell, which I heard distinctly. I immediately rose, and, upon examination, found that it was only one o'clock, and that one stroke only had been struck on the bell: for there was not the smallest derangement in the machinery. After a little reflection, I concluded, that, if we knew not from experience that a single stroke should produce but one sound, every vibration of a bell would be heard as a separate sound, and as if several strokes had successively been repeated on the sonorous body. When I heard the clock strike, I was in the same situation with a person who had heard for the first time, and who, having no idea of the manner in which sound is produced, would judge only by the impression made on the ear; and, on this supposition, he would hear as many distinct sounds as there were successive vibrations.

It is the number of vibrations excited in elastic bodies which constitutes the tone of sound. There is no tone in a simple sound. The report of a gun or the crack of a whip produce different

sounds; but they have no tone. It is the same with every instantaneous sound. Tone consists in the duration of the same sound for a certain time. This duration of sound may be effected in two different ways: the first, and most common, is the succession of vibrations in elastic and sonorous bodies. But the same effect may be produced in nonelastic bodies by a quick repetition of strokes; for a succession of vibrations acts upon the ear in the same manner as if each vibration were a separate stroke.

By considering, in this view, the production of sound, and the different tones which modify it, we shall find, that a repetition of equal strokes is necessary to produce a tone from bodies incapable of vibration. If the number of equal strokes be augmented in the same time, the tone will only be rendered more equal and perceptible, without changing either the sound or the tone produced by the strokes. But, if the force or the equal strokes be augmented, the sound will be stronger, and the tone may be changed. For example, if the force of the stroke be doubled, it will produce a sound doubly strong; and if the tone of the former was an octave, that of the latter will be doubly grave.

May not elastic bodies, when set a vibrating by a single stroke, be regarded as bodies whose figure and length precisely determine the force of the stroke, and limit it to the production of a certain sound only? If one stroke on a bell have only half the force of another, it will not be heard at so great a distance, but it will still produce

the same tone. It is the same with the string of an instrument; the same length gives always the same tone. Should not this lead us to think, that, in the explication of the production of different tones by the greater or smaller number of vibrations alone, we mistake the effect for the cause? For, the vibrations of sonorous bodies being nothing else than what is produced in nonelastic bodies by a frequent repetition of equal strokes, a greater or lesser number of vibrations should have no more influence with regard to tones, than the quicker or slower repetition of strokes made upon bodies which do not vibrate. Now, this quicker or slower repetition of strokes produces no change; neither ought the frequency of vibrations; and the tone, which, in the first case, depends upon the force of the stroke, depends, in the second case, upon the volume of the sonorous body. If it be double the thickness, and of the same length, or double the length, and of the same thickness, the gravity of the one will be double, in the same manner as the tone of a nonelastic body is doubly grave, when struck with a double weight or force.

If we strike a body incapable of vibrating with a double force, or a double mass of matter, it will produce a sound doubly grave, or an octave lower; for it is the same thing as if we struck with two equal masses instead of one of them, which would necessarily double the intensity of the sound. Suppose, then, that two nonelastic bodies are struck, the one with a single mass, the other with two, each of them equal to

the first; a sound would be produced by the first body, whose intensity would be only one half of that produced by the second. But, if we strike one of these bodies with two masses, and the other with three; in this case, the first body would produce a sound, the intensity of which would be one third less than that produced by the second. In the same manner, if we strike the one body with three equal masses, and the other with four, the former will produce a sound, the intensity of which will be one fourth less than that produced by the latter. Now, in comparing numbers, we comprehend them most easily in the proportions of one to two, one to three, one to four, &c.; and, of all the proportions comprehended between the single and the double, those which we perceive with the greatest facility, are two to one, three to two, four to three, &c. Thus, in judging of sounds, the octave corresponds best with the original sound, then the fifth, and then the fourth; because these sounds are in the above proportion. For, if we suppose the small bones of the ear to be hard, unelastic bodies, which receive strokes of equal masses of matter, we would more easily refer the sound produced by one of them to a certain standard, if the other sounds were produced by masses that were proportioned to the first, as one to two, two to three, or three to four; because these are the proportions which the mind recognises with the greatest facility. Thus, in considering sound as a sensation, the pleasure arising from harmony appears to consist in the propor-

tion between the fundamental sound and the others by which it is succeeded. If these other sounds measure exactly the fundamental sound, they will be always harmonious and agreeable; but, if they are incommensurable, they will be harsh and discordant.

It may be asked, why should one proportion, when it is exact, be more agreeable than another, which is less exact? I answer, that the cause of pleasure originates from this justness of proportion; for, whenever our senses are acted upon in this manner, an agreeable sensation is the result; and disproportion, on the contrary, is always disagreeable. We may recollect what was said concerning the blind man who received his sight from the dexterity of Mr. Chesselden. When he began to see, regular objects were more agreeable to him than those which were rough and irregular. It is, therefore, unquestionable, that the idea of beauty, and the pleasing sensations we receive by the eye, originate from regularity and proportion. It is the same with the sense of touching; smooth, round, and uniform bodies, afford us more pleasure than those which are rough and unequal. Thus the pleasure arising from the sense of touching, as well as from that of seeing, is founded in the proportion of objects. Why, therefore, should not the pleasures of the ear proceed from the proportion of sounds?

Sound, like light, is not only propagated at a distance, but is capable of being reflected. The laws which regulate the reflection of sound are not indeed so well understood. All we know